DOCUMENT RESUME

ED 240 375	CE 038 332
TITLE	Electrical. Teacher's Guide. Building Maintenance Units of Instruction.
INSTITUTION	East Texas State Univ., Commerce. Occupational Curriculum Lab.
SPONS AGENCY	Texas Education Agency, Austin. Dept. of Occupational Education and Technology.
PUB DATE	Oct 83
NOTE	211p.; For related documents, see ED 230 789 and CE 038 331.
AVAILABLE FROM	Occupational Curriculum Laboratory, East Texas State University, Commerce, TX 75428 (Order No. TI-216-TG).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; *Buildings; *Building Trades; Competency Based Education; Curriculum Guides; *Electrical Systems; *Electricians; Electricity; Electric Motors; Learning Activities; *Maintenance; Repair; Safety; Secondary Education; Tests; Trade and Industrial Education; Transparencies; Units of Study
IDENTIFIERS	*Building Maintenance Personnel; *Troubleshooting

ABSTRACT

This teaching guide on electrical building maintenance, one in a series of six publications designed for building maintenance instructors in Texas, is designed to give students an understanding of electricity in order to know how to make basic repairs to the electrical systems in a building. Introductory material provides teachers with information on the use of the units of instruction and personalization and localization of the units. Each of the eight units of instruction consists of eight basic components: performance objectives, suggested activities, information sheets (content essential for meeting the cognitive requirements), assignment sheets (application of knowledge), job sheets (procedures to give direction to the skills being taught), transparency masters, unit tests, and test and assignment sheet answers. The eight units cover fundamentals of electricity, electrical safety, electrical tools and materials, the volt-ohm meter and other testing tools, wiring circuits, troubleshooting, minor electrical repairs, and electric motors. (YLB)

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Units of Instruction

BUILDING MAINTENANCE

ELECTRICAL

Teacher's Guide

Prepared under the direction of
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Published by
Occupational Curriculum Laboratory
Center for Vocational Education
Department of Secondary and Higher Education
East Texas State University
Commerce, Texas

in cooperation with
Texas Education Agency
Austin, Texas

CE038 332

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First Edition

1983

October 1983--300 copies

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BUILDING MAINTENANCE: ELECTRICAL

CONTENTS

PREFACE

ACKNOWLEDGEMENTS

USE OF INSTRUCTIONAL UNITS

UNIT NUMBER	UNIT TITLE
I	FUNDAMENTALS OF ELECTRICITY
II	ELECTRICAL SAFETY
III	ELECTRICAL TOOLS AND MATERIALS
IV	THE VOLT-OHM METER AND OTHER TESTING TOOLS
V	WIRING CIRCUITS
VI	TROUBLESHOOTING
VII	MINOR ELECTRICAL REPAIRS
VIII	ELECTRIC MOTORS

PREFACE

BUILDING MAINTENANCE: ELECTRICAL is one in a series of six publications designed for CVAE Building Maintenance instructors in Texas. This multi-year effort is an attempt to provide the entry-level competencies that need to be developed to enable graduates of building maintenance programs to enter employment in a variety of jobs.

This volume is designed to give the student an understanding of electricity in order to know how to make basic needed repairs to the electrical systems in a building. The organization and content are due primarily to the excellent input of the members of the teacher advisory committee who reviewed the materials in the draft stage. This material gives basic information designed to assist teachers in improving instruction, and thus improving student performance. It is the responsibility of each instructor to personalize and localize each lesson in order to meet the needs of the students in a given class.

The instructional materials in this publication are written in terms of student performance based upon measurable objectives. Criterion-referenced tests have been included to provide a means of measurement of student progress.

It is the belief of the OCL staff that the format we use for presentation of material is one of the best. We sincerely encourage feedback from users of our material in order to enable the OCL staff to better meet the needs of vocational students and teachers.

Bill Barnes, Director
Occupational Curriculum Laboratory
East Texas State University

ACKNOWLEDGEMENTS

Appreciation is extended to the many individuals who contributed their time and experience to the development of these materials for BUILDING MAINTENANCE: ELECTRICAL.

The contents of this publication were designed by the statewide Building Maintenance Advisory Committee. Members of this committee generously provided input and reviewed materials as they were developed by the OCL staff. Special thanks must go to the following instructors. This may not be a complete list of participants, as staff for this publication has changed during the development phase of this effort. Our apologies are extended to any instructor who was omitted from the list.

Fred Guyton, Milby High School, Houston
Juan Pablo Garza, McAllen High School, McAllen
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Mary Alice Martinez, Texas High School, Texarkana
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John O'Neal, Wayside Middle School, Saginaw
Herb Cunningham, Terrell High School, Terrell
Joseph Seale, Ringgold Intermediate School, Rio Grande City
Alfred Jost, Stinson Vocational Center, San Antonio
John Grusendorf, Marlin Middle School, Marlin
Bob Hyatt, San Marcos High School, San Marcos

Credit must be extended to the staff of the Division of Occupational Education and Technology for their direction and leadership in initiating and supporting this effort.

Special credit is extended to Danny Stotts for the development of this publication. The organization and contents of this publication are due to his efforts while he was contract writer for the OCL.

Gratitutde is expressed to all members of the OCL staff who, as usual, did an exemplary job in typing, editing, preparation of graphics, and printing of this document.

USE OF THE INSTRUCTIONAL UNITS

The Building Maintenance instructional units cover certain instructional areas in the shop program. Each includes the basic components of a unit of instruction: performance objectives, suggested activities, information sheets, assignment sheets, job sheets, transparency masters, unit tests, and answers to unit tests. Units are planned for more than one classroom period of instruction.

Careful study of each instructional unit will enable the teacher to determine:

A. The amount of material that can be covered in each class period.

B. The skills that must be demonstrated.

C. The supplies and equipment needed for skill performance.

D. The amount of classroom time needed for teacher demonstration and student practice.

E. Supplementary materials that must be ordered.

F. Any resource personnel who must be contacted.

The specific components of an instruction unit perform the following functions:

OBJECTIVES

Each unit of instruction is based on performance objectives. These objectives specify the exact behaviors the students will be exhibiting, thus providing students with a sense of direction.

Performance objectives are stated in two forms. The unit objectives state the material to be covered in the unit of instruction and how the student will handle the material. Specific objectives state the types of performance the student will be doing to satisfy the unit objective.

A classroom discussion should follow immediately after the students read the objectives so that any questions concerning the performances expected of the student can be answered.

SUGGESTED ACTIVITIES

Each unit of instruction has a Suggested Activities Sheet outlining steps to follow in accomplishing specific objectives.

Instructor--Duties of the instructor will vary from unit to unit, but the following are minimum activities for the instructor:

1. Provide students with objectives, information, assignment and/or job sheets.

2. Discuss objectives and information sheets

3. Make transparencies

4. Demonstrate procedures outlined on job sheets (when included)

5. Give test

6. Review the students' tests to identify weak areas

Any additional instructional activities and teaching methods to aid students in accomplishing the objectives are strongly encouraged.

Student--Student activities are listed to help the student achieve the objectives of the unit.

INFORMATION SHEET

Information sheets provide content essential for meeting the cognitive requirements of the unit. These sheets provide an excellent guide for presenting knowledge necessary to develop the skills specified in the unit objective.

Student should read the information sheets before the information is discussed in class. Students are encouraged to make any additional notes on the information sheets to help them in their learning process.

TRANSPARENCY MASTER

Transparency masters provide information in a special way. Transparencies may present new information, or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Make the transparencies from the masters and place them in your notebook ready for immediate use.

Copies of transparency masters can be made and used as student handouts to supplement the material contained in the information sheet.

JOB SHEETS

Job sheets are an integral part of each unit of instruction. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures specified in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress in performing the skill. Job sheets provide a ready outline to students and furnish to potential employers a picture of the types of skills being taught. Job sheets may be used as an individual or teamwork project.

ASSIGNMENT SHEETS

Assignment sheets give direction to study and furnish activities which provide application of the knowledge contained in the information sheets. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided for checking student progress.

UNIT TEST

Unit test questions have been constructed to measure student achievement of each specific objective listed on the objectives sheet. Individual test items may be pulled out and used as an objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the terminal objective.

ANSWERS TO UNIT TEST

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

PERSONALIZING AND LOCALIZING INSTRUCTIONAL UNITS

Carefully review each instructional unit before using in the classroom. In reviewing the units, you may find it necessary to localize and personalize the units based upon your experience and the needs of your students.

Some of the ways of supplementing units are the use of audiovisuals, field trips, resource personnel, games and simulations, case studies, peer teaching, role playing, and personal experiences of both the teacher and students.

Various methods may be used in localizing a unit of instruction. You may wish to apply units of instruction to the local community, add additional materials from newspapers and magazines, invite local resource people, and arrange field trips.

In personalizing a unit of instruction, you may want to make the course content relevant to home and/or work situations. You may wish to involve students in the planning of the unit by using their own personal experiences. Having students involved in the teaching of some of the materials is sometimes an effective example of peer teaching.

Remember that as an instructor, you may wish to add objectives to the units of instruction based on the individual needs of the student or employers in your area. You should add assignment and job sheets as necessary and construct a corresponding unit test item for each added objective.

UNIT I

FUNDAMENTALS OF ELECTRICITY

UNIT OBJECTIVE

After completing this unit, the student will be able to identify terms common to the electrical trade and to recognize the different types of electrical services available. This knowledge will be evidenced through a demonstration and by satisfactory completion of the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match the terms associated with electrical fundamentals to the correct definition.
2. List four uses of electricity.
3. Recognize the types of electric meters.
4. Identify voltage through types of wires leading into a building.

UNIT I

FUNDAMENTALS OF ELECTRICITY

SUGGESTED TEACHING ACTIVITIES

To utilize this unit in the most effective way, the instructor should review the material and then localize and individualize for the class being taught. Combine or divide the material included to meet the time available and the ability of the students.

I. Objective Sheet

   A. Review all objectives, and then add or delete to meet (your own) program objectives.

   B. Review and discuss with the students each specific objective as it relates to the training program.

II. Information Sheet

   A. Explain the terms and definitions to the students.

   B. Discuss the uses of electricity and encourage the students to participate by exploring all of the ways that electricity relates to daily living.

   C. After discussing the different types of electrical power plants, conduct a field trip to any power plants in your community. Arrange for a company representative to explain how the power is transmitted to homes and businesses.

   D. Invite a representative of a local power company to visit your class to explain types of meters and how electricity rates are formulated.

III. Transparency masters

   (NOTE: Transparency masters are included in the student manuals and can be used as information sheets.)

   A. TM-1--Transmission Lines

   B. TM-2- Distribution Lines

   C. TM-3--Pointer-Dial Electric Meter

   D. TM-4--Cyclometer Electric Meter

IV. Evaluation

   A. The unit test has only one part.

   B. Various approaches may be used in testing, depending on how the unit has been presented.

      1. The test may be given after completion of the information sheet.

      2. Use the test as an assignment sheet.

3. Allow those students who respond better to an oral test to do so individually as time allows.
4. Include test questions for any material that was added to the unit.

V. Answers to the test

A. Answers are based on information covered in the unit.

B. For convenience in grading, be sure to include answers for any questions added to the test.

VI. References

A. Coordinated Vocational Education and Training-General Construction Trades. Stillwater, Okla.: State Department of Vocational and Technical Education.

B. Construction Industry Series, Student Manual Preparation and Development. Austin, Texas: Texas Education Agency.

C. Construction Industry Series, Instructor's Guide-Preparation Level. Austin, Texas: Texas Education Agency.

D. Mix, Floyd M. House Wiring Simplified. South Holland, Ill: The Goodheart-Wilcox Co.

E. Understanding Electricity and Electrical Terms. Athens, GA: American Association for Vocational Instructional Materials Engineering Center.

UNIT I

FUNDAMENTALS OF ELECTRICITY

INFORMATION SHEET

I. Terms and definitions

A. Alternating current (AC)--Electrical current flowing in one direction at regular intervals.

B. Ampere (AMP)--A unit of measure of electrical current flowing through a wire.

C. Circuit--A complete path through which electricity flows, such as from the power source through a lamp and back to the power source.

D. Circuit breaker--A safety device which opens the circuit by tripping a switch rather than burning out the wiring or appliance.

(NOTE: A circuit breaker can be reset after cooling.)

E. Conductors--Materials through which electrical current flows.

F. Direct current (DC)--Electrical current flowing in one direction at a continuous rate.

G. Electricity--A form of energy which can be converted to practical use.

H. Electric meter--A device which measures the amount of electricity used in kilowatt hours.

I. Fuse--A safety device which burns out when current becomes too great.

J. Ground--A connection to the earth which serves as a return circuit.

(NOTE: Ground wires also prevent electrical shock.)

K. Horsepower (HP)--A unit of mechanical power which is equal to 746 watts of electrical power.

L. Hot wires--The current-carrying conductor with electrical pressure on it.

M. Insulation--A protective covering over wires to prevent completing a circuit except where desired.

N. Kilowatt (KW)--1000 watts.

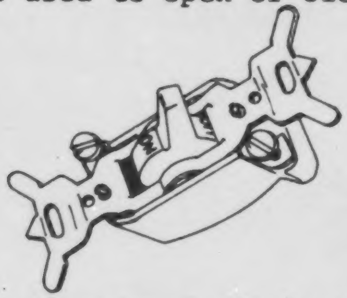
O. Kilowatt hour (KWH)--1000 watts used for one hour.

P. Neutral wire--The current-carrying conductor with no electrical pressure on it.

Q. Resistance (OHM)--Electrical friction.

R. Short circuit--An improper connection between hot and neutral wires or between two hot wires.

S. Switch--A device used to open or close a circuit.



T. Volt (V)--A unit of measure of electrical pressure.

U. Watt (W)--A unit of measure used in determining electrical power.

V. Watt hour--One watt used for one hour.

II. Uses of electricity

A. Lighting

B. Heating

C. Cooling

D. Power

E. Communications

F. Special

III. Types of electrical power plants

A. Hydro-electric plants

B. Gas-fired electric plants

C. Coal-fired electric plants

D. Atomic generated plants

IV. Types of individually owned electrical generators

A. Wind powered

B. Gasoline powered

C. Solar powered

V. Types of power companies

A. Publicly owned

B. Privately owned

C. Cooperatives

VI. Types of power lines (TM-1 & TM-2)

A. Transmission lines--Electrical lines that extend from generating plant to sub-station or distribution center.

B. Distribution lines--Electrical lines that begin at the sub-station or distribution center and extend to the user.

(NOTE: Usually running under 20 miles.)

C. Service lines--Electrical lines that run from the meter to the point of use, e.g., a house.

VII. Different electrical services

A. 110-volt--Requires two lines running to the house.

B. 220-volt--Requires three lines running to the house.

VIII. Electricity rates

A. Residential

B. Commercial

C. Special

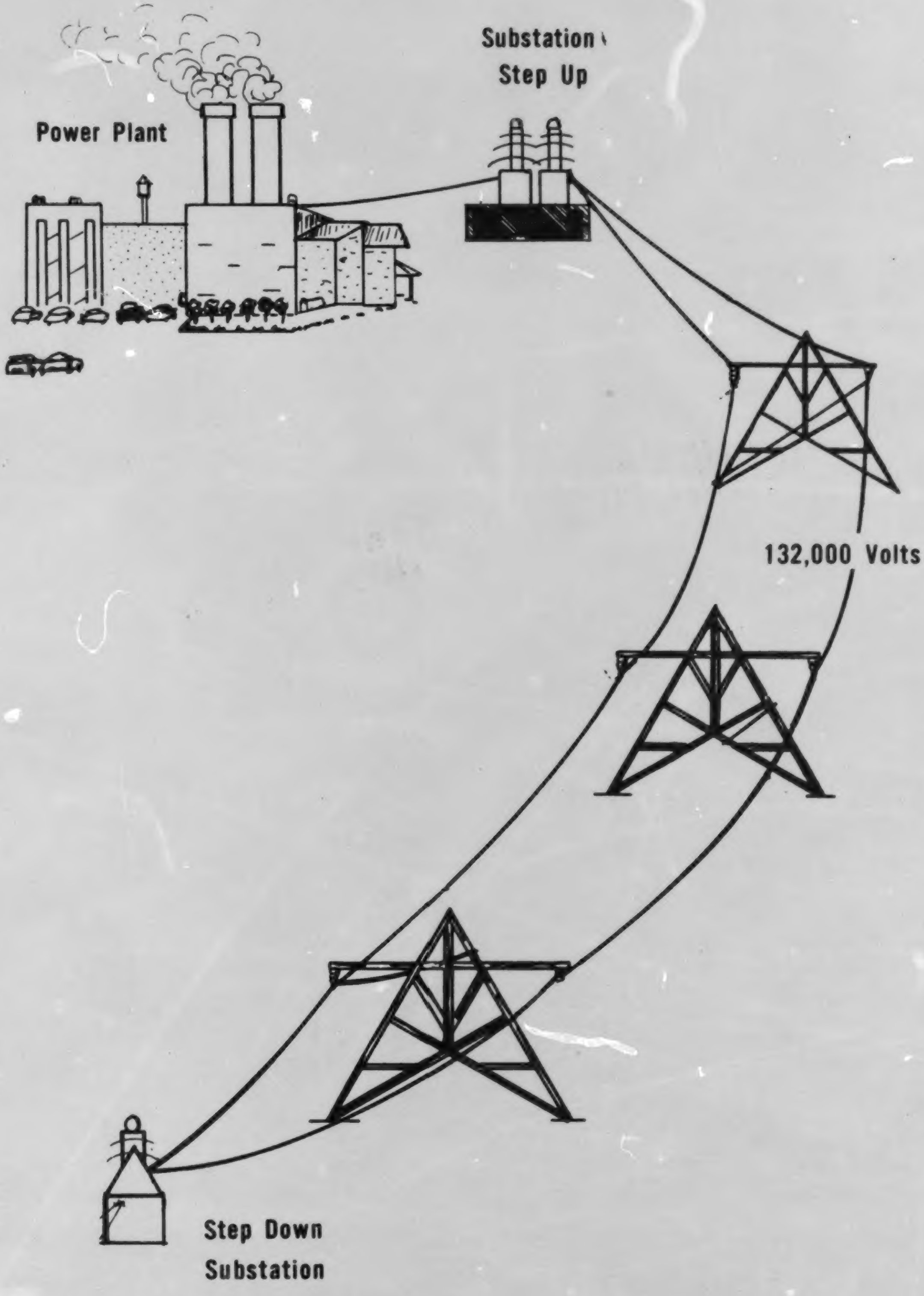
D. Fuel adjustment

IX. Types of electric meters

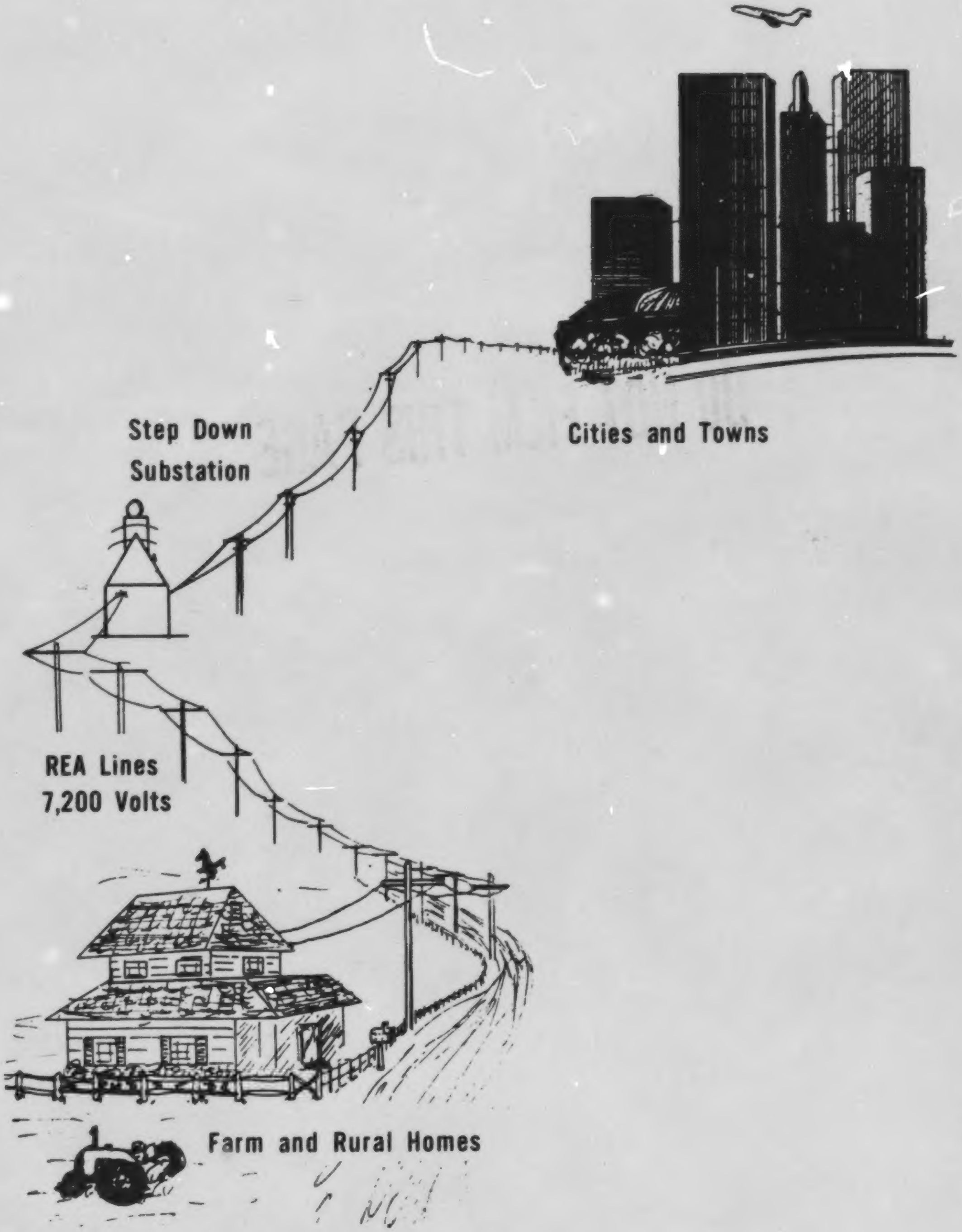
A. Pointer and dial (TM-3)

B. Cyclometer (TM-4)

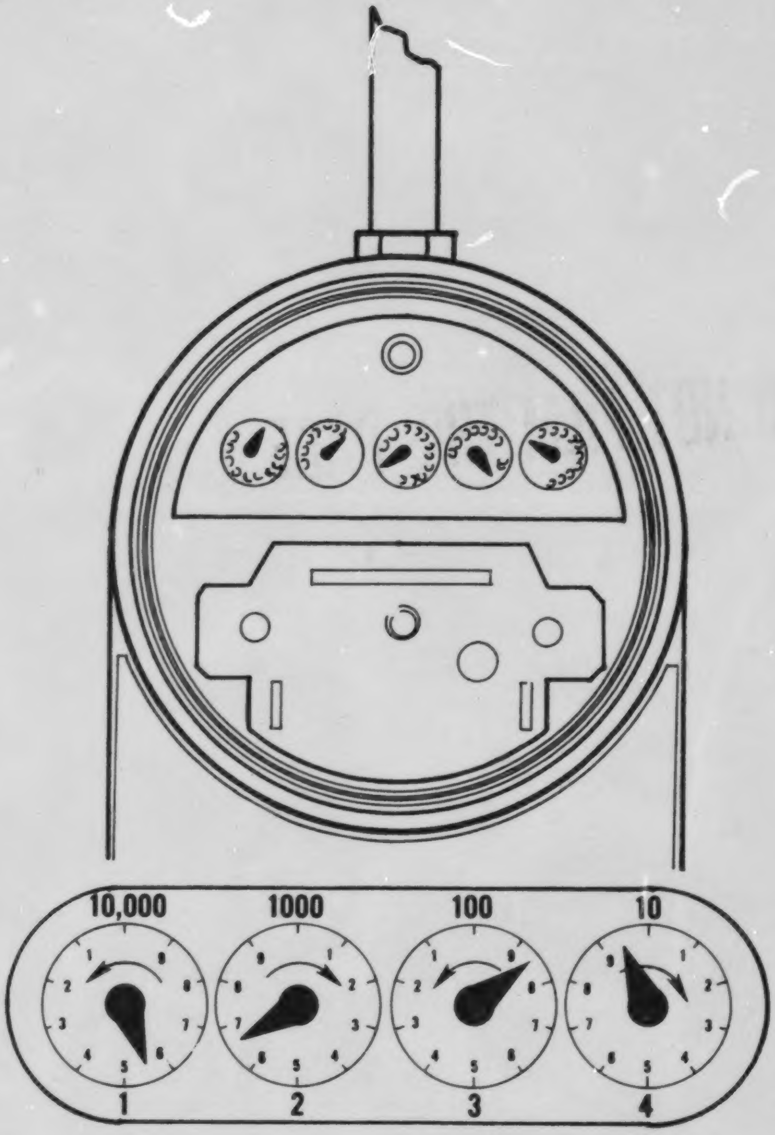
TRANSMISSION LINES



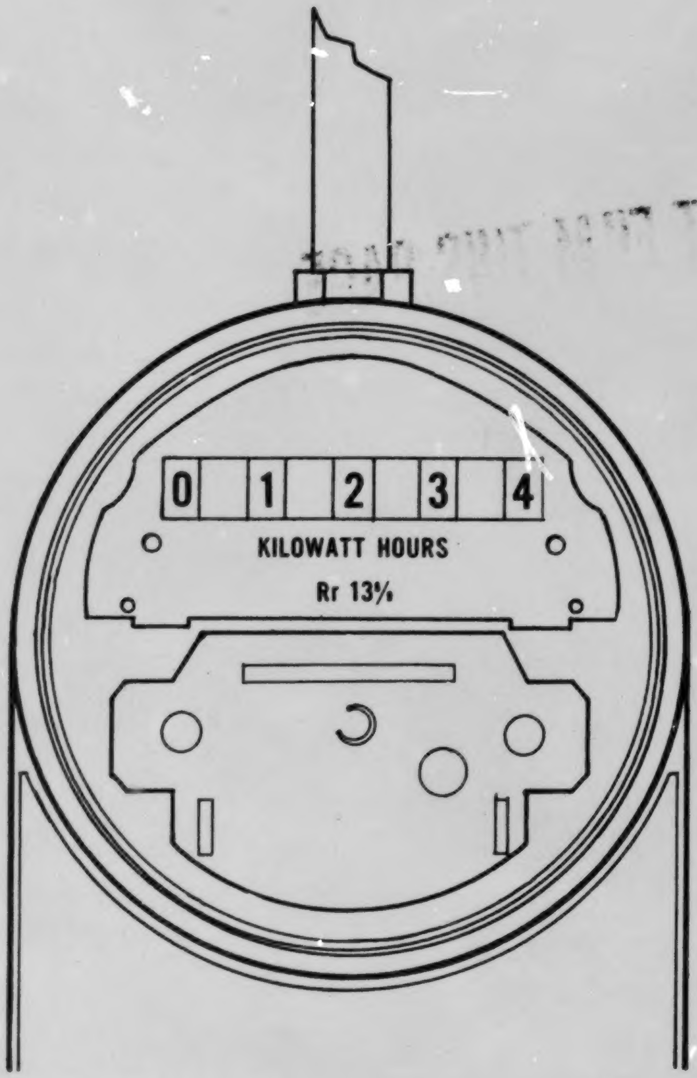
DISTRIBUTION LINES



POINTER DIAL ELECTRIC METER



CYCLOMETER ELECTRIC METER



UNIT I

FUNDAMENTALS OF ELECTRICITY

TEST

1. Match the terms in the right hand column to the correct definition on the left by placing the number in the blank.

_____ a. A source of energy that can be converted to light, heat or power.

_____ b. A unit of measure of electrical power.

_____ c. 1,000 watts

_____ d. A unit of measure of electrical pressure.

_____ e. A device used to open and close a circuit.

_____ f. Path through which electricity flows.

_____ g. 1,000 watts for 1 hour.

_____ h. A unit of mechanical power equal to 746 watts.

_____ i. Material through which electrical current flows.

_____ j. The current-carrying conductors with electrical pressure on it.

_____ k. Usually the white wire.

_____ l. Reduces the danger of electrical shock.

1. Kilowatt
2. Switch
3. Kilowatt-hour
4. Horsepower
5. Electricity
6. Watt
7. Conductors
8. Volt
9. Hot wire
10. Ground
11. Circuit
12. Neutral wire

2. List four uses of electricity.

a.

b.

c.

d.

3. Place a "✓" in the blank beside the terms below which identify a type of electrical power plant.

_____ a. Hydro-electric

_____ b. Gas-fired

_____ c. Wood-fired

_____ d. Atomic

4. Place a "✓" in the blank beside the terms below which identify a type of individual electrical generator.

_____ a. Wind-powered _____ c. Gasoline-powered
_____ b. Horse-powered _____ d. Solar-powered

5. Place a "✓" in the blank beside the terms below which identify a type of power company.

_____ a. Public _____ c. Cooperative
_____ b. Combined _____ d. Private

6. Arrange the types of power lines listed below in the proper order from power plant to user by placing the number 1, 2, 3, or 4 in the blank beside the term.

_____ a. Distribution line _____ c. Feeder line
_____ b. Transmission line _____ d. Service line

7. Identify voltage sizes of power sources by filling in the following blanks with either 110 or 220.

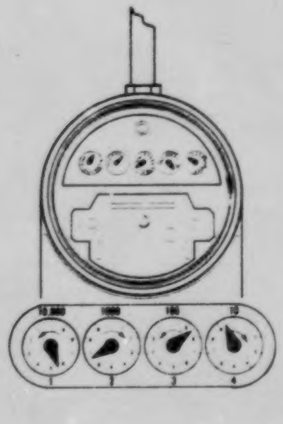
A house with three electric lines leading to it has (a) ________-volt service, and if there are only two lines leading to it, it has a (b) ________-volt service.

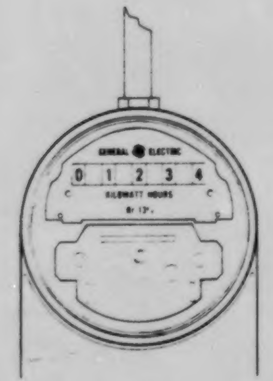
8. List two types of electrical rates.

a.

b.

9. Identify the two meters below by writing the name of each in the blank below.





a. ______________________ b. ______________________

UNIT I

FUNDAMENTALS OF ELECTRICITY

ANSWERS TO TEST

1. a. 5
   b. 6
   c. 1
   d. 8
   e. 2
   f. 11
   g. 3
   h. 4
   i. 7
   j. 9
   k. 12
   l. 10

2. Any four of these six.

   a. Lights
   b. Heating
   c. Cooling
   d. Power
   e. Communications
   f. Special

3. ✓ a.
   ✓ b.
   ✓ c.
   ______ d.

4. ✓ a.
   ______ b.
   ✓ c.
   ✓ d.

5. ✓ a.
   ______ b.
   ✓ c.
   ✓ d.

6. 2 a.
   1 b.
   4 c.
   3 d.

7. a. 220
   b. 110

8. Any two of these four.

   a. Residential
   b. Commercial
   c. Special
   d. Fuel adjustment

9. a. Pointer and dial
   b. Cyclometer

UNIT II

ELECTRICAL SAFETY

UNIT OBJECTIVE

After completing this unit, the student will use safe procedures while working with electricity and recognize unsafe situations in the home and shop. This knowledge will be evidenced through demonstration and by satisfactorily completing the test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match the terms and definitions associated with electrical safety.
2. List four results of electrical accidents.
3. Identify the effects of electrical accidents.
4. Point out the common causes of electrical accidents.
5. Point out the proper procedures for helping an electrical shock victim.
6. List three classes of fires.
7. Determine for which class of fire each type of extinguisher is used.
8. Select correct work area safety factors.
9. Identify correct tool and equipment safety factors.
10. Select correct electrical installation factors.
11. Select special precautions in electrical safety.
12. Demonstrate the ability to:
    a. Identify unsafe electrical conditions in the shop and classroom.
    b. Identify unsafe electrical conditions in the home and garage.
    c. Identify five types of fire extinguishers.
    d. Prepare an electrical safety poster.

UNIT II

ELECTRICAL SAFETY

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

   A. Discuss unit objective with students.

   B. Discuss each specific objective with the students and relate each to electrical safety.

   C. Organize the sequence of the objectives into a plan that will fit the local shop situation.

   D. Add any objectives that you feel are needed by your program.

II. Information Sheet

   A. Use this sheet to introduce electrical work to the student.

   B. Stress the importance of every safety factor presented.

   C. Emphasize over and over the reasons for observing safety rules.

III. Transparency Masters

   (NOTE: Transparency masters are included in each student manual and may be used as information sheets.)

   A. TM-1--Effects of Electrical Accidents

   B. TM-2--Results of Electrical Accidents

   C. TM-3--Human Failure

   D. TM-4--Failure

   E. TM-5--Carelessness

   F. TM-6--Misuse

   G. TM-7--Electrical Shock Victims

   H. TM-8--Types of Fire Extinguishers

   I. TM-9--Work Area Safety

IV. Assignment Sheets

A. ASSIGNMENT SHEET 1--SAFETY SURVEY

1. Allow each student to conduct an individual survey.

2. Make a master list, including all hazards the class members found.

3. Post the list in a conspicuous place as a constant reminder of safety requirements.

B. ASSIGNMENT SHEET 2--SAFETY INSPECTION

1. Discuss the unsafe conditions found.

2. Have the student give suggestions for eliminating each safety hazard noted.

C. ASSIGNMENT SHEET 3--IDENTIFY FIVE TYPES OF FIRE EXTINGUISHERS

1. Have on hand examples of as many different types of fire extinguishers as possible.

2. Demonstrate how a fire extinguisher is to be used.

3. Discuss why it is important to respect fire extinguishers and the reasons NOT to treat them as toys.

D. ASSIGNMENT SHEET 4--PREPARE ELECTRICAL SAFETY POSTER

1. Talk about ideas for a poster in order to help the student get started.

2. Display the posters in the shop at appropriate places.

V. Unit Evaluation

A. Have the student complete the test.

B. After checking the evaluation, discuss any areas the student did not understand.

VI. References

A. Mix, Floyd. House Wiring Simplified. South Holland, Ill: Goodheart-Wilcox Company, Inc. 1973.

B. General Construction Trades. State Department of Vocational and Technical Education, Stillwater, Oklahoma, 1971.

C. Electricity. Construction Industry Series Student Manual. Austin, Texas: Texas Education Agency, 1975.

D. National Safety Council Catalog and Poster Directory. National Safety Council, 425 N. Michigan Ave., Chicago, Ill, 60611. 1975-76.

UNIT II

ELECTRICAL SAFETY

INFORMATION SHEET

I. Terms and definitions

A. Accident--Any sudden, unplanned event which causes injury or property damage.

B. Safety--State or condition of being safe, free from danger, risk, or injury.

C. Electrical shock--The result of electrical discharge through a person's body.

D. Defective--Not in proper working order.

E. Approved--Minimum standards established by authorities have been met.

F. Ground--A connection to the earth which serves as a return circuit and reduces danger.

G. Short circuit--Improper connection between hot wires, or between hot and neutral wires.

H. Overload--A circuit or device forced to carry more electrical current than design allows.

I. Live wire--Current-carrying wire.

(NOTE: Current kills!)

J. Dead circuit--A disconnected circuit, usually caused by removing fuse, tripping breaker, or disconnecting service.

K. Modification--A slight change in form or operation.

L. Qualified person--A person who knows the work area involved.

II. Effects of electrical accidents (TM-1)

A. Shock

B. Burns

C. Falls and spills

D. Cuts and abrasions

III. Results of electrical accidents (TM-2)

A. Death--One amp for one second of contact can cause death.

B. Crippling--Severe burns can cause loss of limb, sight, or mobility.

C. Loss of time--Electrical-associated accidents account for 4% of job time lost in the U.S. each year.

D. Loss of material--Fire caused by electricity results in millions of dollars of material loss each year.

E. Loss of job--Most employers will not keep a dangerous worker on the job.

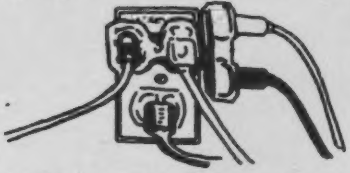
IV. Common causes of electrical accidents

A. Human failure--Not using safe work practices. (TM-3)

B. Failure--Not making necessary repairs to faulty equipment. (TM-4)

C. Carelessness--Not observing safety rules. (TM-5)

D. Modification--Making unauthorized changes in equipment.



E. Misuse--Using something in the wrong way. (TM-6)

F. Defective equipment

1. Ground wire
   - a. Missing
   - b. Broken
   - c. Improper connection
   - d. Not connected

2. Insulation
   - a. Wet
   - b. Worn
   - c. Cut
   - d. Oily

G. Defective tools

  1. Broken guard

  2. Damaged power cord

  3. Improper or no switch

  4. Broken handle

  5. Loose fasteners

H. Ignorance--Not knowing the correct thing to do.

V. Electrical shock victims (TM-7)

A. If possible, turn OFF electricity causing shock.

B. Remove hot wire from victim by using dry wood, plastic, glass, or fiberglass article.

CAUTION: Never touch the victim: you will also receive the shock.

C. Remove victim from source of electricity after insulating yourself with thick layers of dry paper or cloth. You could be shocked just by touching the victim.

D. Give mouth-to-mouth resuscitation.

E. Call an ambulance or doctor.

F. Notify power company.

G. Watch for possible electrical fires.

VI. Classes of fires

A. Class A--Caused by ordinary burnable materials, such as rags, paper, and wood.

B. Class B--Caused by flammable liquids, such as gasoline, oil, and paint thinner.

C. Class C--Electrical fires in wires or electric motors.

VII. Types of fire extinguishers (TM-8)

A. Soda-acid--Use on Class A fires only.

B. Pressurized water--Use on Class A fires only.

C. Foam--Use on Class A and B fires only.

D. Carbon dioxide--Use on Class A, B, or C fires.

E. Dry chemical--Use on Class A, B, or C fires.

VIII. Work area safety factors (TM-9)

A. Keep work area free of loose tools.

B. Keep work area free of loose materials and trash.

C. Keep floors free of water, oil, grease, or other liquids.

D. Work only on dead circuits.

E. Practice good housekeeping and work habits.

IX. Tool and equipment safety factors

A. Operate equipment properly.

B. Use clean tools.

C. Use insulated handles to prevent shock.

D. Keep cutting tools sharp.

E. Use the right tools for the job to be done.

X. Electrical installation safety factors

A. Check circuit with test light before starting work.

B. Keep all equipment and tools dry.
CAUTION: This is a MUST!

C. Work on only one side of a circuit at a time.

D. Insulate your body when working with live wires by wearing:

1. Lineman's gloves
2. Rubber-soled shoes
3. Approved electrical worker's hard hat

E. Work on dead circuits (the electricity is turned OFF) whenever possible.

F. Ladders

1. Use wooden ladders that are unpainted and in good repair.
   CAUTION: DO NOT use metal ladders for electrical work because you could get an electrical shock.

2. Place ladder one-fourth of the ladder's length away from wall.

3. Be sure all feet of folding ladders are level on the ground or floor so the ladder is steady.

G. Cut away from the body when stripping wire with a knife.

XI. Special precautions in electrical safety

A. DO NOT bypass breakers or fuse with "jumpers."

B. DO NOT install higher amp-rated fuse or breaker than recommended.

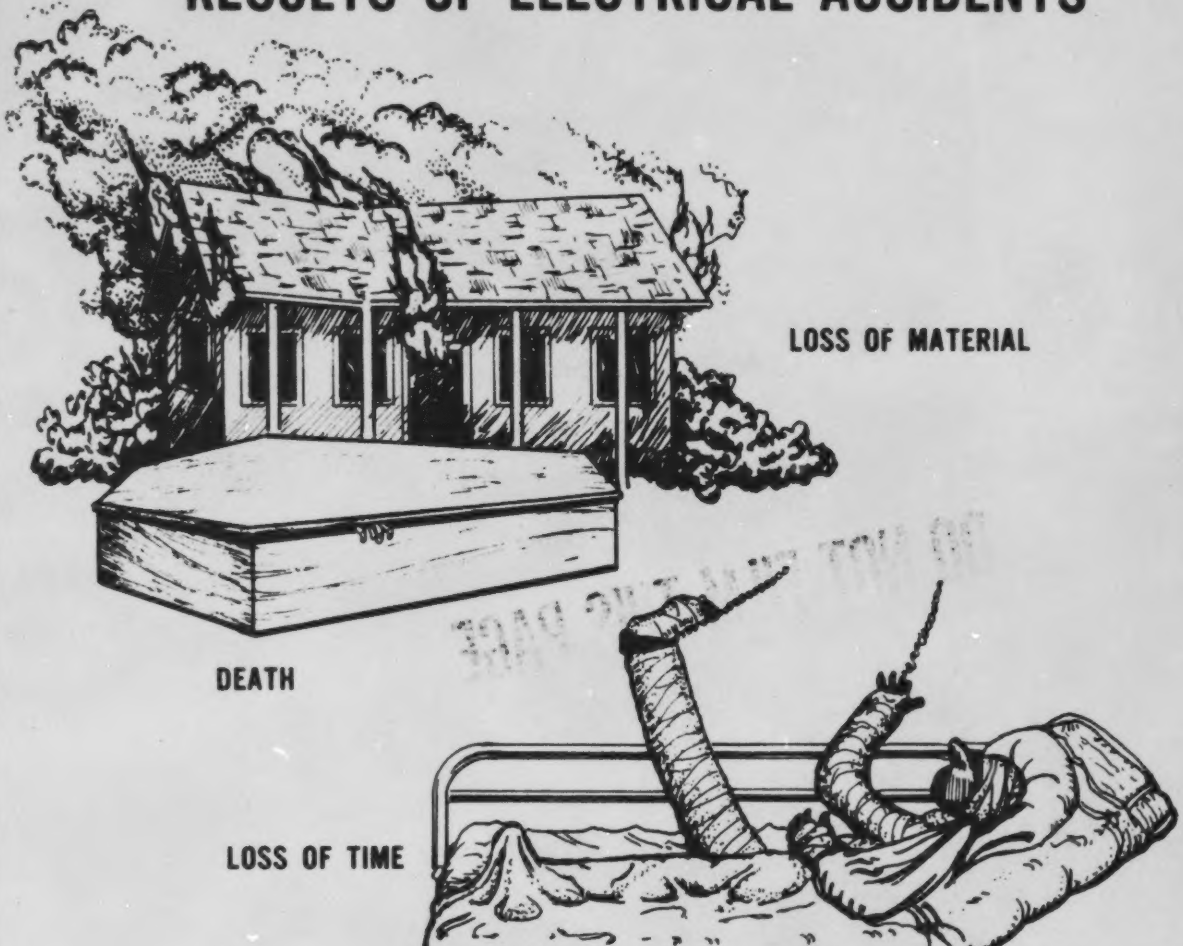
C. DO NOT place coins or foil behind a fuse.

D. DO NOT overload a circuit.

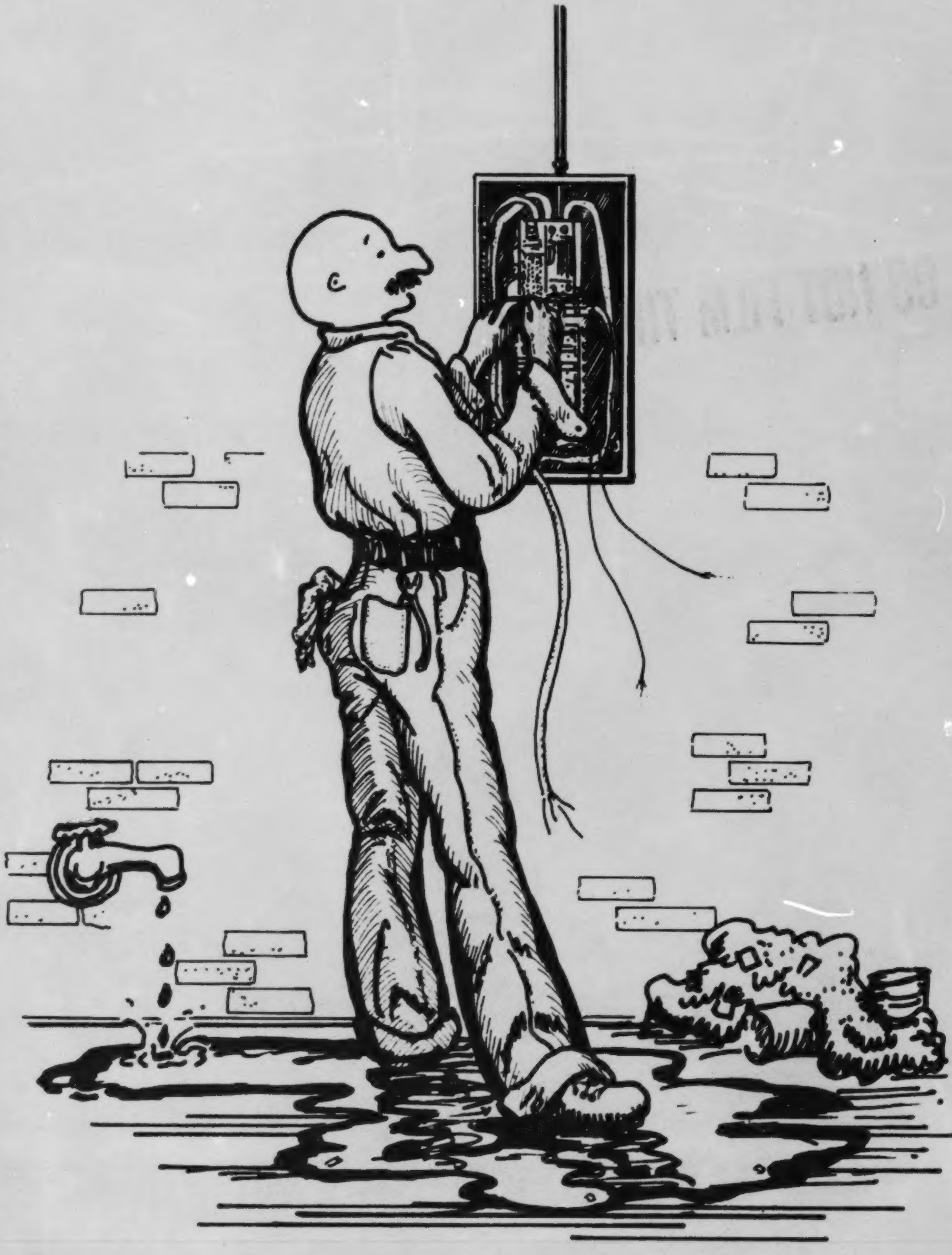
EFFECTS OF ELECTRICAL ACCIDENTS

TM-1

RESULTS OF ELECTRICAL ACCIDENTS



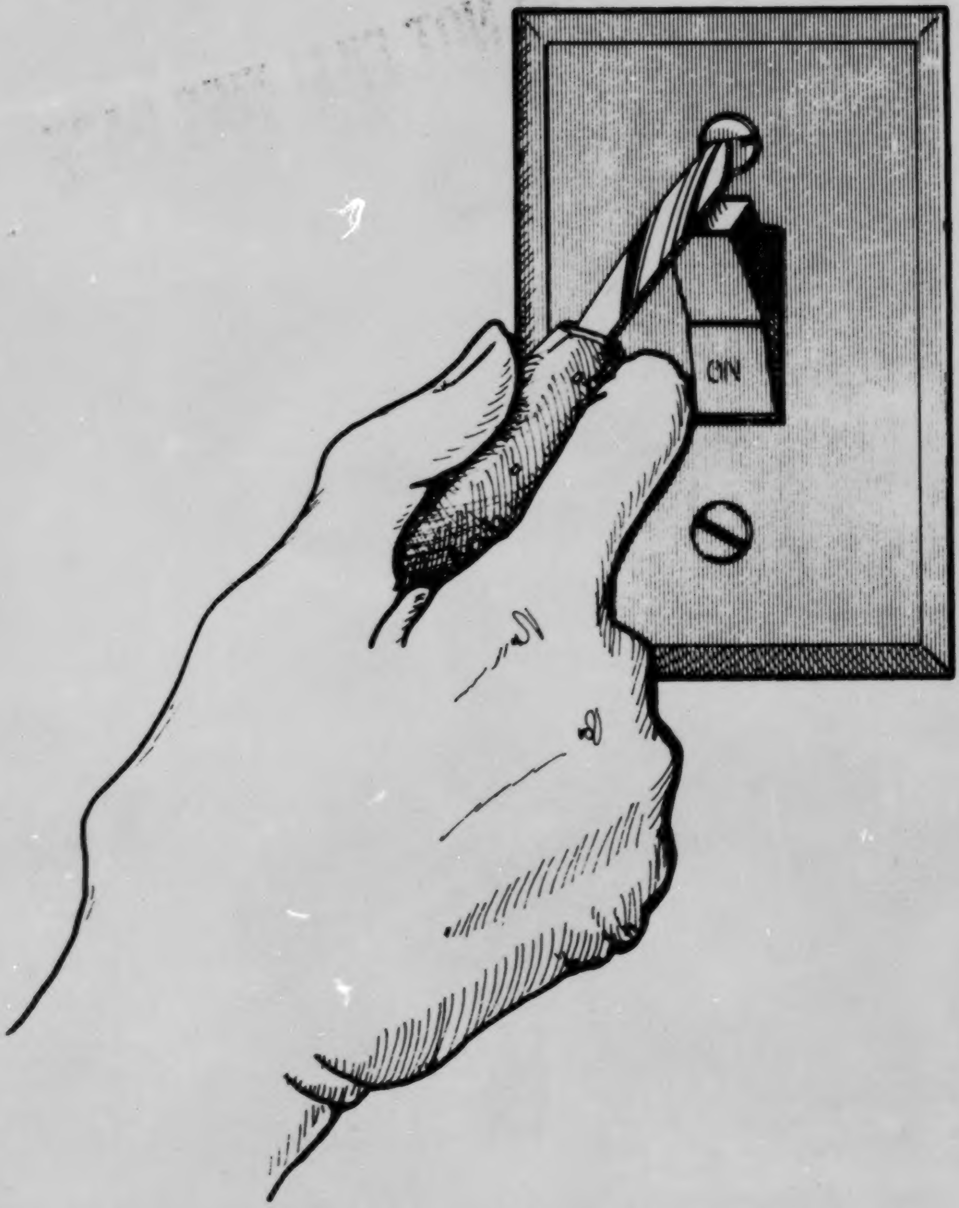
HUMAN FAILURE



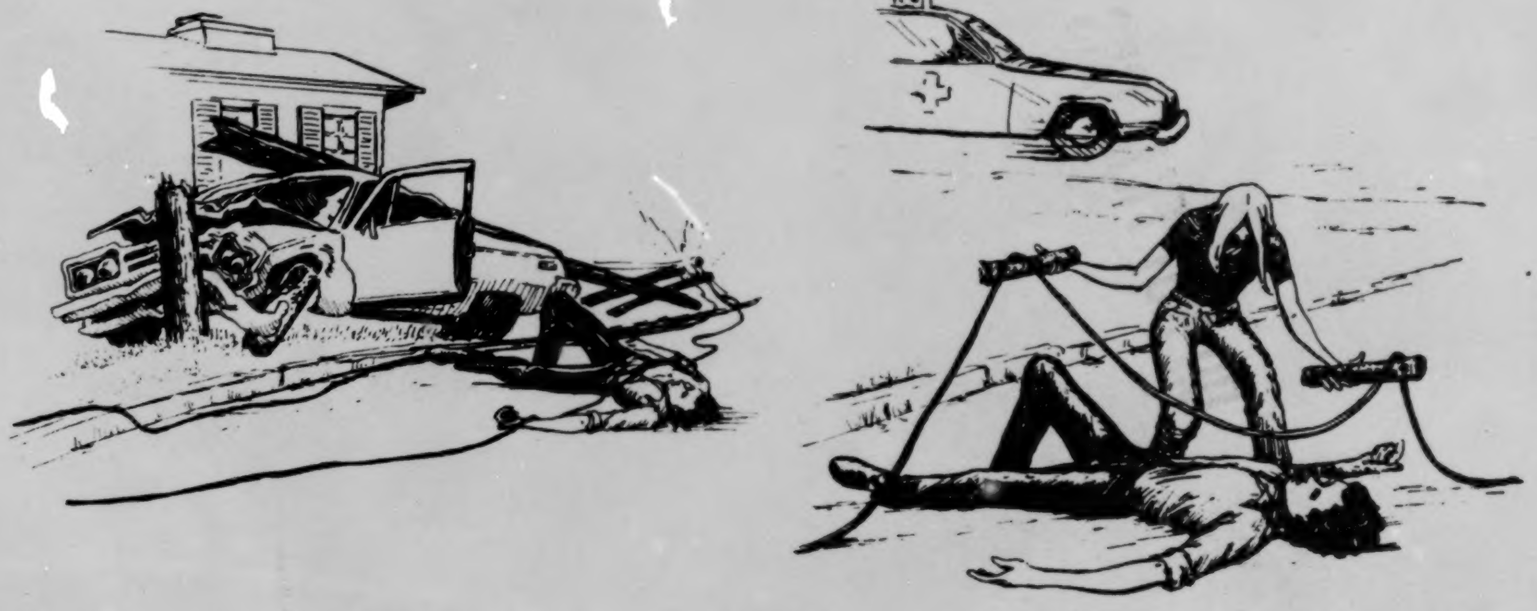
FAILURE

CARELESSNESS

MISUSE

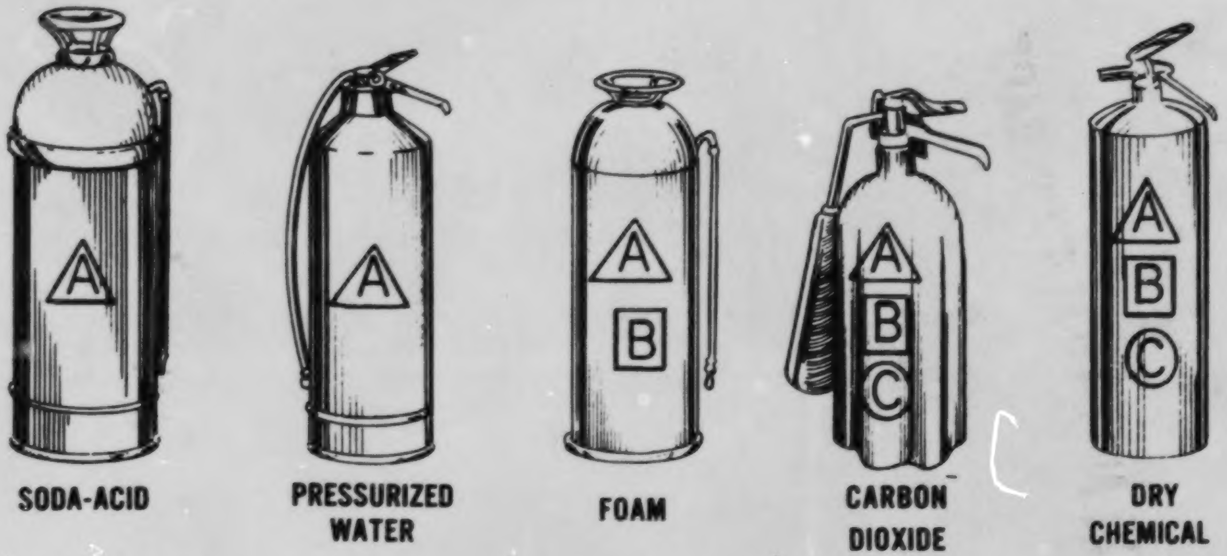


ELECTRICAL SHOCK VICTIMS



USE A NON-CONDUCTOR (NEWSPAPER, STICK, RUBBER HOSE) TO REMOVE A LIVE WIRE FROM A PERSON.

TYPES OF FIRE EXTINGUISHERS

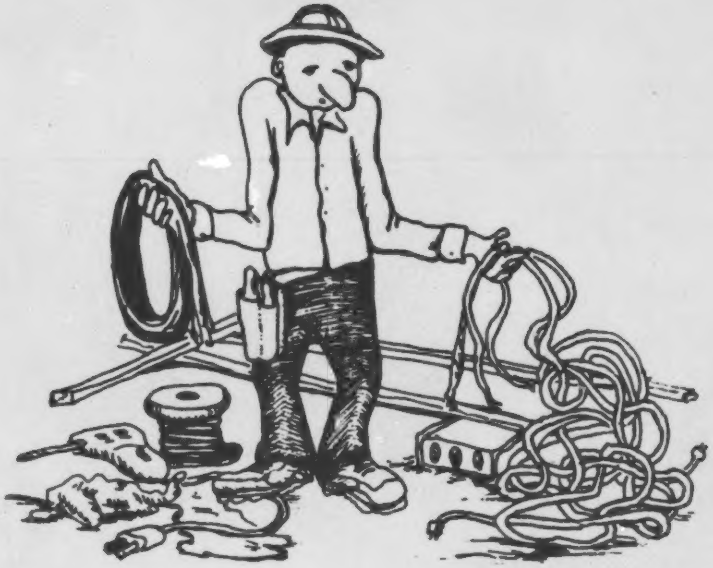


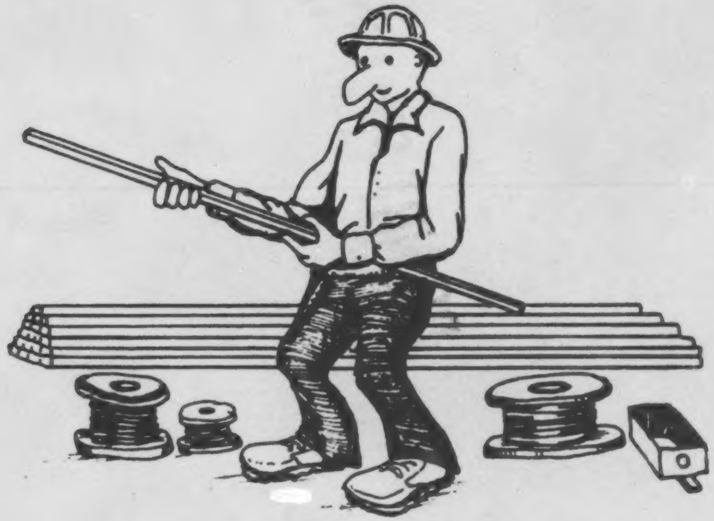
A **CLASS A** - Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish.

B **CLASS B** - Fires that occur with flammable liquids, such as gasoline, oil, paints, and thinners.

C **CLASS C** - Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring.

WORK AREA SAFETY





TM-9

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UNIT II

ELECTRICAL SAFETY

ASSIGNMENT SHEET 1--SAFETY SURVEY

Directions: Look around the shop and classroom to see if you can find any unsafe electrical conditions. List any hazards you find. Be sure to check all wall outlets, switches, motors, tools, and extension cords. Your survey will be used to help make the shop and classroom a safer place in which to learn.

UNIT II

ELECTRICAL SAFETY

ASSIGNMENT SHEET 2--SAFETY INSPECTION

Directions: Look around your home and garage and see if you can find any unsafe electrical conditions. Make a note of any you find and bring your list to class. The following are some of the things you may want to look for.

A. Extension cords hung over nails

B. Worn or frayed electrical cords

C. Switches not working properly

D. Light bulbs near flammable materials

E. Outlets overloaded

F. Electrical cords under rugs or on floor in traffic areas

G. Television set near flammable material

H. Outlets in poor condition, with no covers

I. Fuse box with improper fuses

J. Appliances not grounded

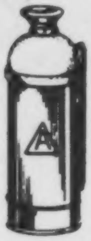
K. Main switch hard to reach

UNIT II

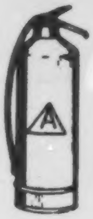
ELECTRICAL SAFETY

ASSIGNMENT SHEET 3--IDENTIFY FIVE TYPES OF FIRE EXTINGUISHERS

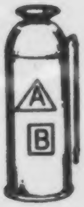
Directions: Identify the five types of fire extinguishers shown below using Part VII of the Information Sheet and Transparency 8. Write the name of each in the blanks.



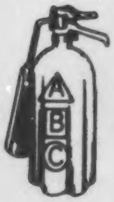
A. ____________________



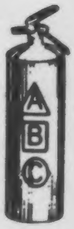
B. ____________________



C. ____________________



D. ____________________



E. ____________________

UNIT II

ELECTRICAL SAFETY

ASSIGNMENT SHEET 4--PREPARE ELECTRICAL SAFETY POSTER

Directions: On a piece of poster board or a sheet of typing paper, prepare a poster about electrical safety. You may want to use some of the rules listed in the Information Sheet for ideas in making your poster.

(NOTE: The instructor may want to display your poster as a safety reminder.)

UNIT II

ELECTRICAL SAFETY

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheets 1 and 2

Evaluated to the satisfaction of the instructor

Assignment Sheet 3

A. Soda-acid

B. Pressurized water

C. Foam

D. Carbon dioxide

E. Dry chemical

Assignment Sheet 4

Evaluated to the satisfaction of the instructor

UNIT II

ELECTRICAL SAFETY

UNIT TEST

1. Match the electrical safety terms listed at the right to the correct definition on the left by placing the number of the correct term in the blank at the left.

_____ a. The result of electrical discharge through a person's body

_____ b. Any sudden, unintentional event which causes injury or property damage

_____ c. State or condition of being safe, free from danger, risk or injury

_____ d. A connection to the earth which serves as a return circuit and reduces danger

_____ e. Not in proper working order

_____ f. Current-carrying wire

_____ g. A disconnected circuit

_____ h. Improper connection between hot wires or between hot and neutral wires

_____ i. Minimum standards set by authorities have been met

_____ j. A circuit or device forced to carry more electrical current than design allows

1. Accident
2. Safety
3. Electrical shock
4. Defective
5. Approved
6. Ground
7. Short circuit
8. Overload
9. Live wire
10. Dead circuit
11. Modification
12. Qualified person

2. List four results of electrical accidents.

   a.

   b.

   c.

   d.

3. Identify the effects of electrical accidents by placing a "✓" in the blank beside the terms which apply.

   _____ a. Death

   _____ b. Crippling

   _____ c. Loss of time

   _____ d. Loss of material

   _____ e. Loss of job

4. Point out the common causes of electrical accidents by writing the number of each term on the right in the correct blank on the left.

   _____ a. Not using safe work practices

   _____ b. Using something in an improper manner

   _____ c. Not making necessary repairs

   _____ d. Not observing safety rules

   _____ e. Ground wire missing

   _____ f. Broken handle

   _____ g. Not knowing proper procedure

   1. Ignorance
   2. Defective equipment
   3. Failure
   4. Carelessness
   5. Modification
   6. Human failure
   7. Defective tool
   8. Misuse

5. Point out the proper procedures for helping an electrical shock victim by placing a "✓" in the blank beside the correct statements only.

    _____ a. Turn off electricity causing shock.

    _____ b. Remove hot wire from victim, using a metal rod.

    _____ c. Give mouth-to-mouth resuscitation.

    _____ d. Call an ambulance or doctor.

    _____ e. Notify gas company.

    _____ f. Watch for possible electrical fire.

6. List three classes of fires.

    a.

    b.

    c.

7. Determine for what class or classes of fire each of the following types of extinguishers may be used.

    Class

    a. Soda-acid _____

    b. Pressurized water _____

    c. Foam _____

    d. Carbon dioxide _____

    e. Dry chemical _____

8. Select the correct work area safety factors by placing a "✓" in the blank beside the correct statement only.

    _____ a. Work area must be free of loose tools.

    _____ b. Keep loose material in work area.

    _____ c. Floors must be free of oil, water, grease and other liquids.

    _____ d. Work only on live circuits.

    _____ e. Keep good housekeeping and work habits.

9. Identify the correct tool and equipment safety factors by writing either SAFE or UNSAFE in each of the blanks below.

_____ a. Proper operation of equipment.

_____ b. Keep tools greased.

_____ c. Insulate handles.

_____ d. Keep cutting tools sharp.

_____ e. Use the tool most handy.

10. Select the correct electrical installation safety factors by placing a "✓" in the blank beside the correct statements only.

_____ a. Check circuit with test light before starting work.

_____ b. Equipment and tools must be dry.

_____ c. Work on either side of circuit.

_____ d. Wear approved hard hat.

_____ e. Use painted metal ladder.

_____ f. Cut away from body when stripping wire.

11. Select the correct special precautions in electrical safety by placing a "✓" in the blank beside the correct statements only.

_____ a. Use bypass "jumpers" on breakers and fuses.

_____ b. Do not install higher amp-rated fuse or breaker than recommended.

_____ c. If fuse is blown, place coin or foil behind the fuse.

UNIT II

ELECTRICAL SAFETY

ANSWERS TO TEST

1. a. 3
   b. 1
   c. 2
   d. 6
   e. 4
   f. 9
   g. 10
   h. 7
   i. 5
   j. 8

2. a. Shock
   b. Burns
   c. Falls and/or spills
   d. Cuts and/or abrasions

3. ✓ a.
   ✓ b.
   ✓ c.
   ✓ d.
   ✓ e.

4. a. 6
   b. 8
   c. 3
   d. 4
   e. 2
   f. 7
   g. 1

5. ✓ a.
   b.
   ✓ c.
   ✓ d.
   e.
   ✓ f.

6. a. Class A
   b. Class B
   c. Class C

7. a. Class A only
   b. Class A only
   c. Class A and B
   d. Class A, B or C
   e. Class A, B or C

8. ✓ a.
   b.
   ✓ c.
   d.
   ✓ e.

9. safe a.
unsafe b.
safe c.
safe d.
unsafe e.

10. ✓ a.
✓ b.
____ c.
✓ d.
____ e.
✓ f.

11. ____ a.
✓ b.
____ c.
✓ d.

UNIT III

ELECTRICAL TOOLS AND MATERIALS

UNIT OBJECTIVE

After completing this unit, the student will be able to identify electrical tools and materials. This knowledge will be evidenced through demonstration and by satisfactorily completing a unit test.

SPECIFIC OBJECTIVES

After completion of this unit the student will be able to:

1. Match the terms and definitions associated with electrical tools and materials.
2. Identify five types of wire conductors.
3. Identify types of conduit.
4. Select the types of electrical boxes.
5. Identify the types of electrical connectors.
6. Select the types of electrical covers.
7. List three types of switches.
8. Select the types of electrical outlets and receptacles.
9. Identify electrical safety devices.
10. Match electrical tools to the correct name.
11. Select items found in an electrical service entrance.
12. Demonstrate the ability to:
    a. Select the proper terms for electrical materials.
    b. Select the correct names for electrical tools.
    c. List nine major parts of an electrical service entrance.

UNIT III

ELECTRICAL TOOLS AND MATERIALS

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

A. Discuss unit objectives with students.

B. Discuss each specific objective with the students and relate each to electrical tools and materials.

C. Organize the sequence of the objectives to fit local shop organization and procedures.

D. Add any objectives necessary to fit local needs and program.

II. Information Sheet--Electrical Tools and Materials

A. This sheet presents basic information concerning electrical work any electrician must know.

B. Using this information, the instructor should give the student numerous drills and tests in order to reinforce the importance of knowing about tools and materials.

III. Transparency Masters

(NOTE: The transparency masters are furnished in the student manuals as an additional means of reinforcing the information sheet.)

A. TM-1--Types of Wire Conductors

B. TM-2--Types of Conduit

C. TM-3--Types of Electrical Boxes

D. TM-4--Types of Electrical Connectors

E. TM-5--Types of Electrical Covers

F. TM-6--Types of Switches

G. TM-7--Types of Outlets and Receptacles

H. TM-8--Types of Electrical Safety Devices/Fuses

I. TM-9--Safety Devices

J. TM-10--Circuit Breaker

K. TM-11--Tools Used In Electrical Wiring

L. TM-12--Screwdrivers

- M. TM-13--Drills and Bits
- N. TM-14--Types of Saws and Hammers
- O. TM-15--Soldering Equipment
- P. TM-16--Measuring Devices
- Q. TM-17--Special Tools and Equipment
- R. TM-18--Electrical Service Entrance

IV. Assignment Sheets

- A. Assignment Sheet 1--Identify Electrical Conductors
- B. Assignment Sheet 2--Identify Electrical Tools
- C. Assignment Sheet 3--Identify Service Entrance Parts
- D. Unit test
- E. Answers to unit test

V. Unit Evaluation

- A. Give the students the unit test.
- B. After checking the tests, discuss those items that gave the students the most trouble.
- C. Give additional opportunities for reinforcing those areas.

VI. References

A. Mix, Floyd. House Wiring Simplified. South Holland, OK: Goodheart-Wilcox Co., Inc. 1973.

B. General Construction Trades. Stillwater, OK: State Department of Vocational and Technical Education, 1971.

UNIT III

ELECTRICAL TOOLS AND MATERIALS

INFORMATION SHEET

- I. Terms and definitions
  - A. Conduit--Metal or plastic pipe used to enclose conductors
  - B. Outlet--Place in wiring system where appliances may be attached to the receptacle
  - C. Receptacle--Device installed at the outlet for a connection of appliances
  - D. Duplex--Double receptacle
- II. Types of wire conductors (TM-1)
  - A. Nonmetallic cable (NM)
  - B. Thermal wire cable (TW)
  - C. Metallic armored cable (BX)
  - D. Power service cord (SJ)
  - E. Lamp cord (rubber or braided insulation)
- III. Types of conduit (TM-2)
  - A. Thinwall (EMT) Electrical Metallic Tubing
  - B. Rigid
  - C. Flexible
- IV. Types of electrical boxes (TM-3)
  - A. Octagonal ceiling or junction
  - B. Rectangular wall switch or outlet
  - C. Surface mounted
  - D. Special
    - 1. Waterproof
    - 2. Shallow
- V. Types of electrical connectors (TM-4)
  - A. Conduit connectors
    - 1. Indenter type
    - 2. Compression type
    - 3. Coupler

B. Conductor connectors
  1. Wire nuts
  2. Soldered and taped

VI. Types of electrical covers--plastic or metal (TM-5)

A. Duplex receptacle
B. Toggle switch
C. Combination duplex and switch
D. Specialty

VII. Types of switches (TM-6)

A. Single pole
B. Three-way
C. Mechanical quiet
D. Mercury

VIII. Types of outlets and receptacles (TM-7)

A. Duplex without ground
B. Duplex with ground
C. 208-240V
D. Surface mount 240V
E. Weatherproof

IX. Types of electrical safety devices

A. Fuses (TM-8)
  1. Plug
  2. Blade
  3. Cartridge
  4. Type S
  5. Time delay
B. Circuit breaker (TM-10)

X. Tools used in electrical wiring (TM-11)

A. Pliers
  1. Slip joint
  2. Lineman
  3. Diagonal cutter
  (Note: often called "dikes")

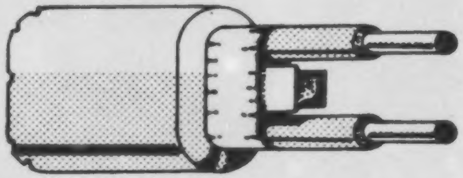
    4. Long nose
    5. End cutter
    6. Channellock
    7. Vise-grip
    8. Wire stripper
B. Screwdrivers (TM-12)
    1. Straight slot
    2. Phillips point
    3. Stubby
    4. Screwdriver bit
C. Drills and bits (TM-13)
    1. Drills
        a. Power
        b. Bit brace
        c. Hand drill
    2. Bits
        a. Augur
        b. Wood twist
        c. Expansive
        d. Twist drill
        e. Masonry
        f. Star drill
D. Types of saws (TM-14)
    1. Crosscut hand
    2. Keyhole
    3. Hack
    4. Power hand or circular
E. Hammers
    1. Claw
    2. Lineman
    3. Ball peen
F. Soldering equipment (TM-15)
    1. Soldering iron
    2. Soldering gun
    3. Propane torch
    4. Solder
    5. Soldering paste

- G. Measuring devices (TM-16)
  - 1. 6- to 12-foot push-pull tape
  - 2. 50- to 100-foot steel tape
  - 3. Folding rule
- H. Special tools and equipment (TM-17)
  - 1. Equipment for wire pulling
    - a. Steel fish tape
    - b. Polyethylene fish tape
    - c. Wire pulling lubricant
  - 2. Cutting and bending tools
    - a. Pipe cutter
    - b. Pipe threader
    - c. Conduit bender
    - d. Wood chisel
    - e. Utility knife
  - 3. Testing tools
    - a. Ammeter
    - b. Battery
    - c. Buzzer
    - d. Oscilloscope
    - e. Test lamp

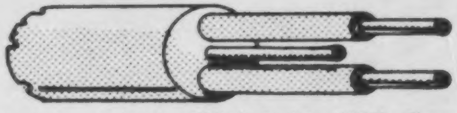
XI. Parts of an electrical service entrance (TM-18)

- A. Lead wires
- B. Entrance head
- C. Meter box
- D. Entrance ell
- E. Neutral bar
- F. Single-pole breaker
- G. Two-pole breaker
- H. Main breaker
- I. Panel

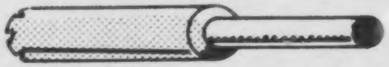
TYPES OF WIRE CONDUCTORS



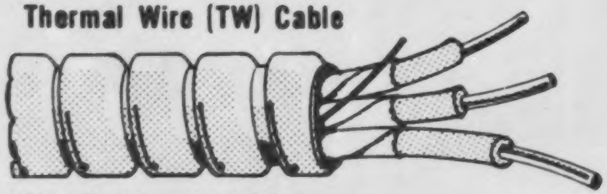
Non-metallic (NM) Cable Without Ground



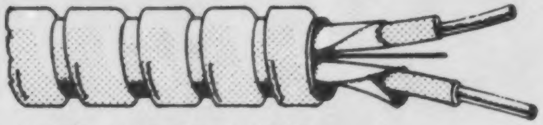
Non-metallic (NM) Cable With Ground



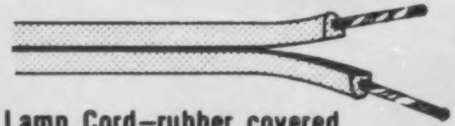
Thermal Wire (TW) Cable



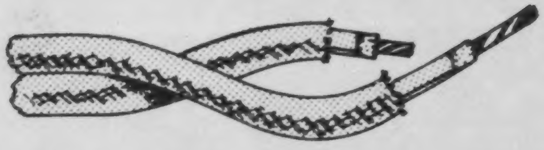
Metallic Armored Cable



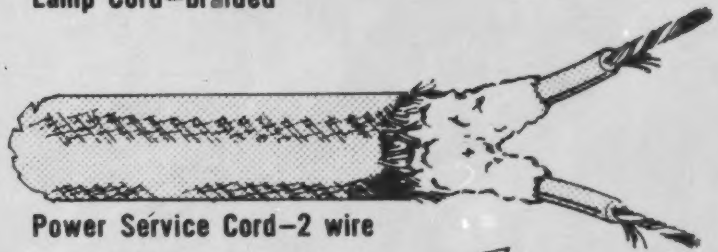
Metallic Armored Cable



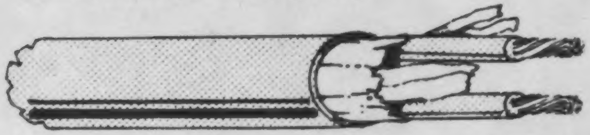
Lamp Cord–rubber covered



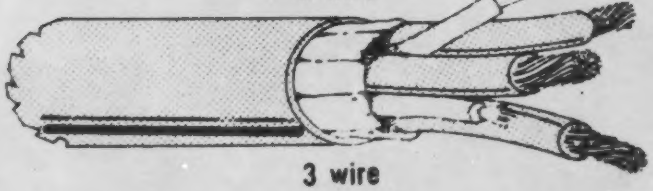
Lamp Cord–braided



Power Service Cord–2 wire



2 wire

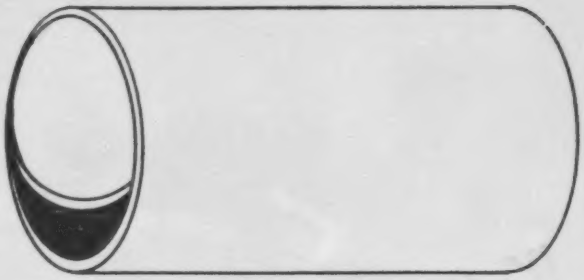


3 wire

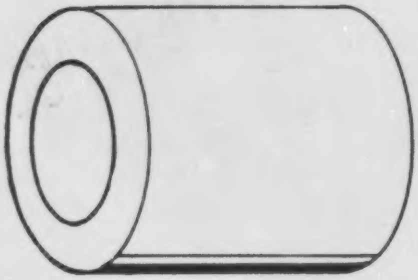
TM-1

73

TYPES OF CONDUIT



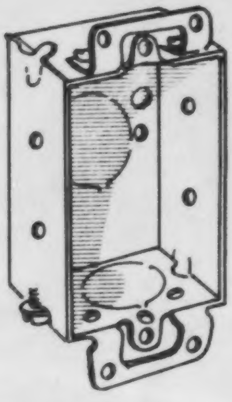
Thin Wall Conduit



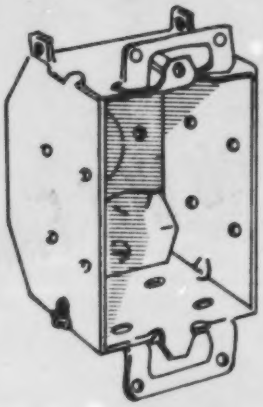
Rigid Conduit

Flexible Conduit

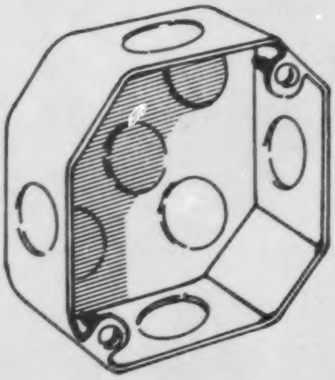
TYPES OF ELECTRICAL BOXES



Shallow Boxes

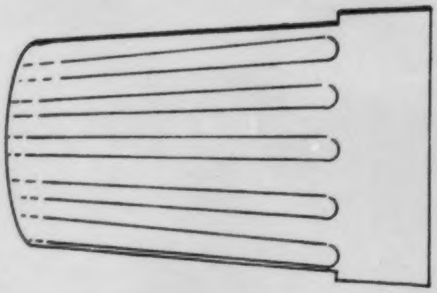


Rectangular Switch or Outlet Box

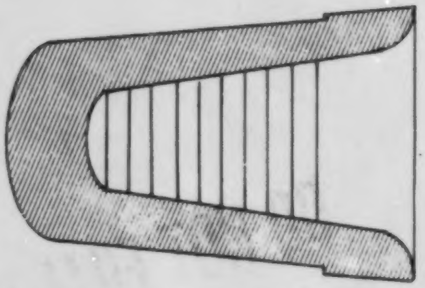


Octagon Box

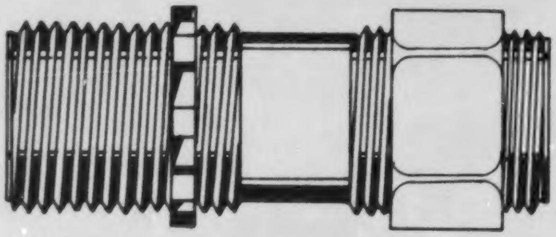
TYPES OF ELECTRICAL CONNECTORS



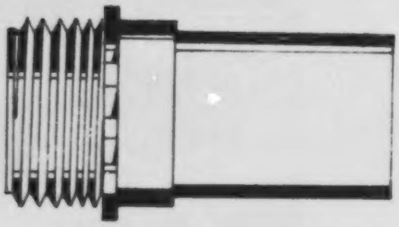
Wire Nut



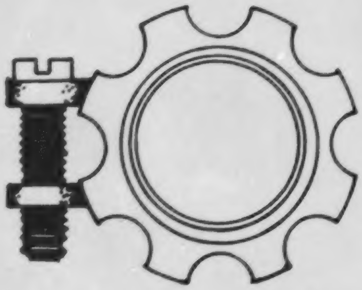
NM Wire Connector



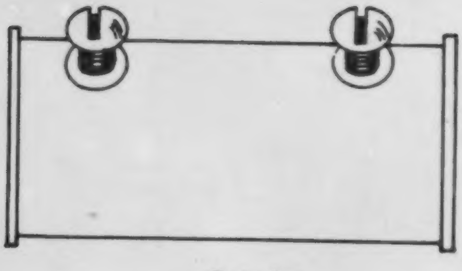
Compression Type Connector



Indenter Connectors

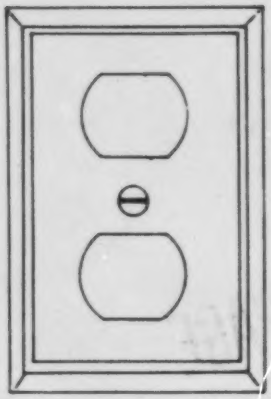


CONNECTOR

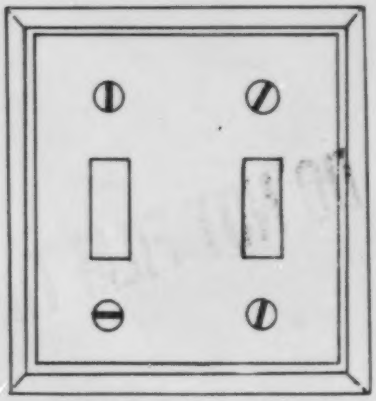


Coupler

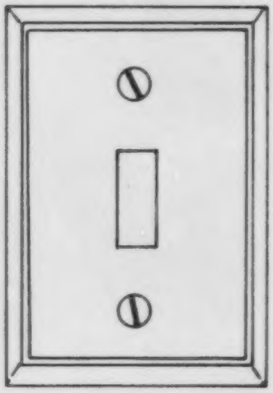
TYPES OF ELECTRICAL COVERS



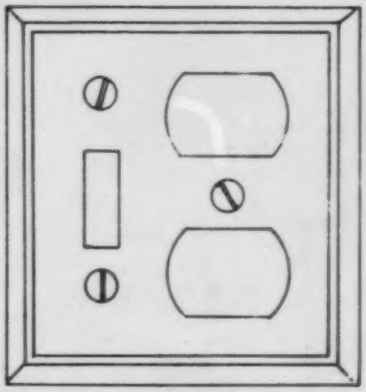
Duplex Receptacle Cover



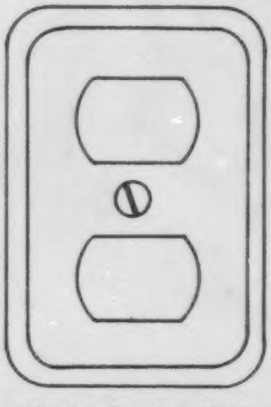
Double Switch Cover



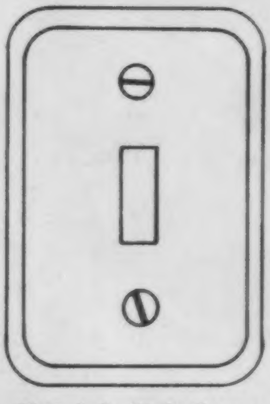
Single Switch Cover



Combination Switch and Duplex

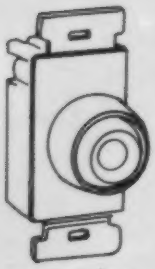


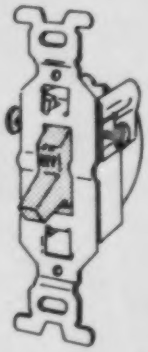
Metal Duplex Cover

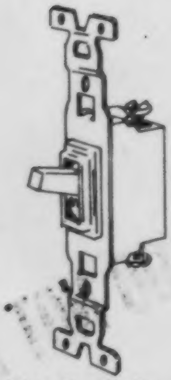


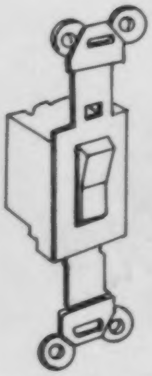
Metal Switch Cover

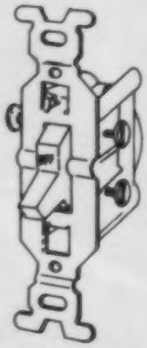
TYPES OF SWITCHES

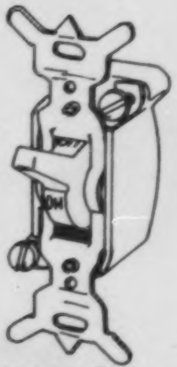

Dimmer Switch


Single Pole Switch

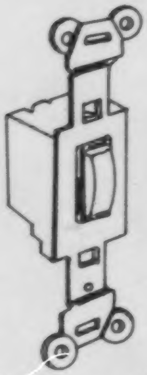

Single Pole
Quiet Switch


Lever-Action Switch

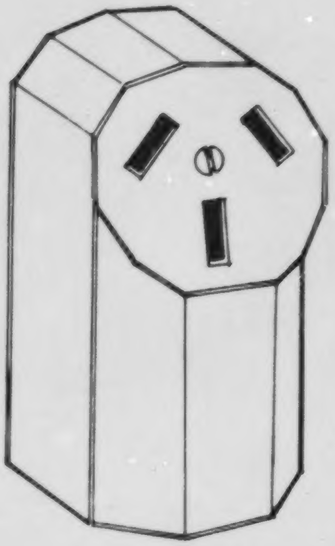

Three Way Switch



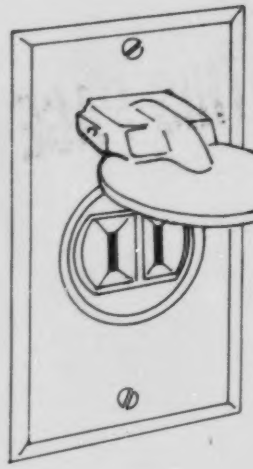
Single Pole
Mercury Switch


Push-Button
Action Switch

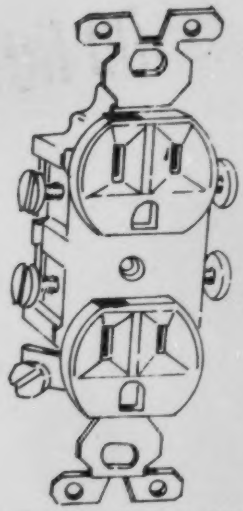
TYPES OF OUTLETS AND RECEPTACLES



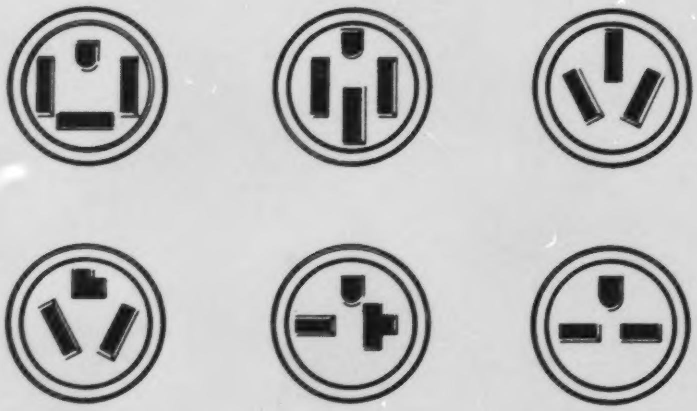
50-Amp Outlet



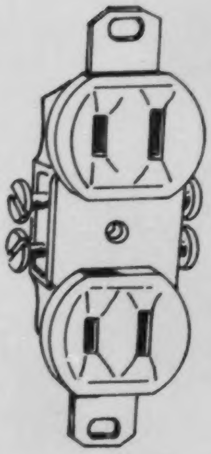
Weatherproof receptacle



Duplex Outlet With
Grounding Terminal

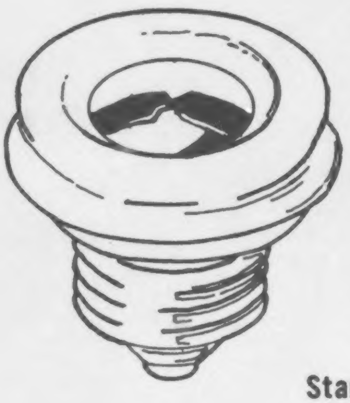


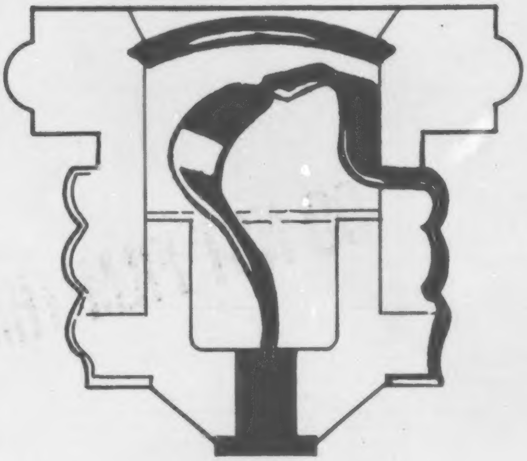
208-240 Volt Outlets



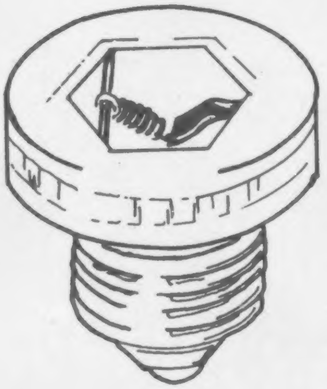
Duplex Outlet Without
Grounding Terminal

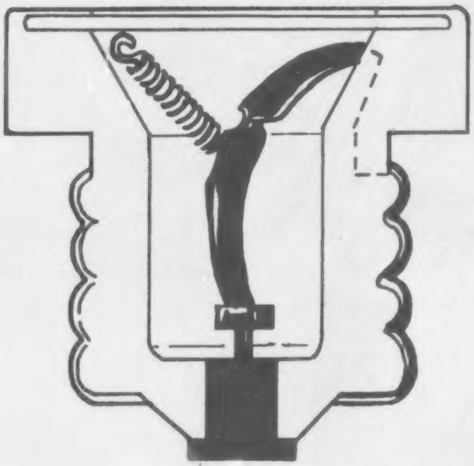
TYPES OF ELECTRICAL FUSES





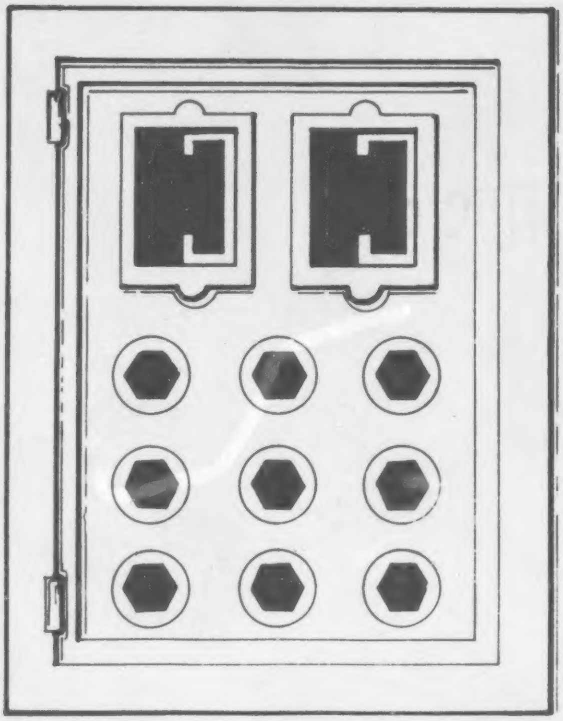
Standard Fuse



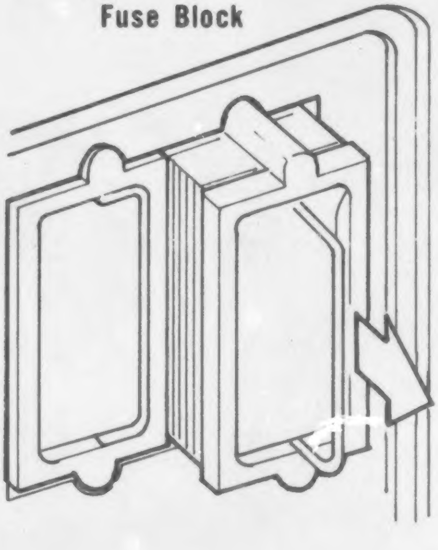


Time-Delay Fuse

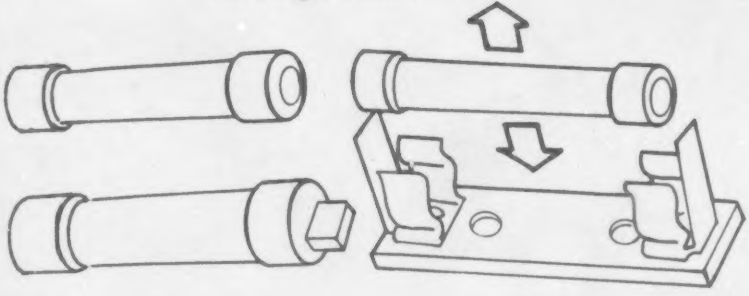
SAFETY DEVICES



Fuse Panel

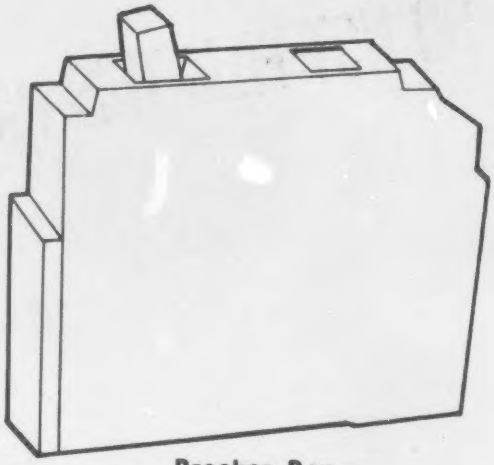


Fuse Block

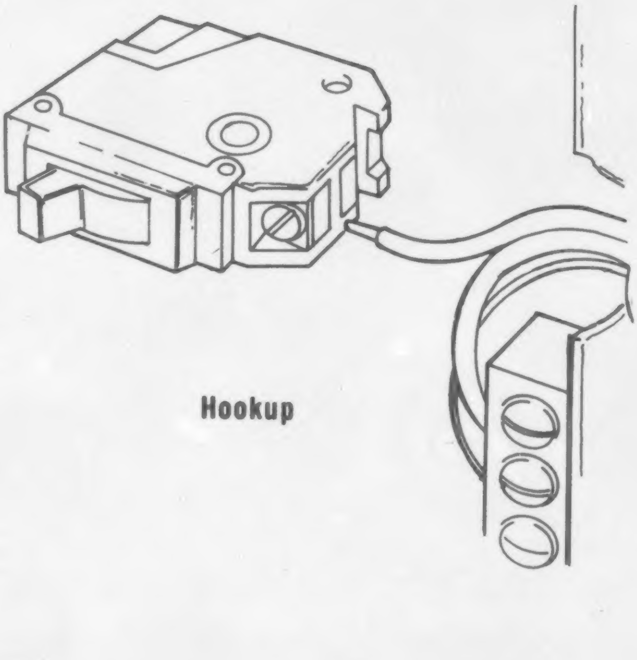


Cartridge Fuses

CIRCUIT BREAKER

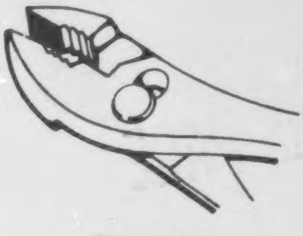


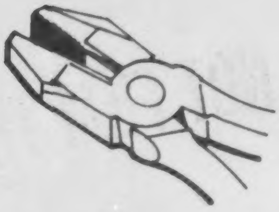
Breaker Box

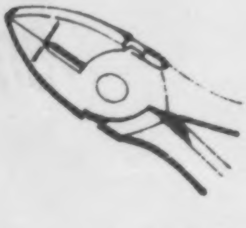


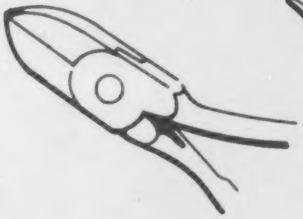
Hookup

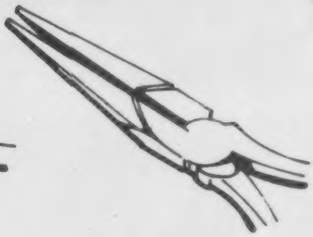
TOOLS USED IN ELECTRICAL WIRING

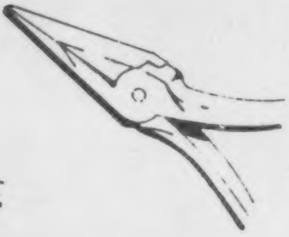

Slip Joint

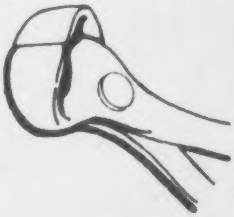

Lineman's

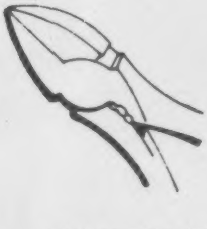

Side Cutting

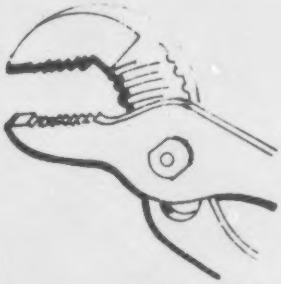

Diagonal Cutting

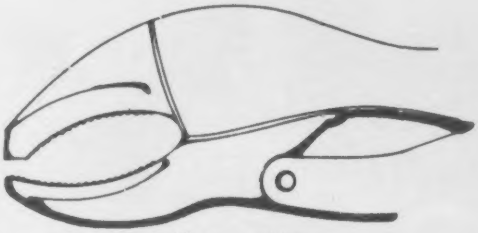

Long Nose

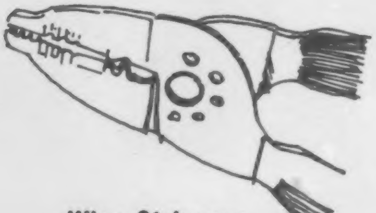

Chain Nose


High Leverage
End Cutting

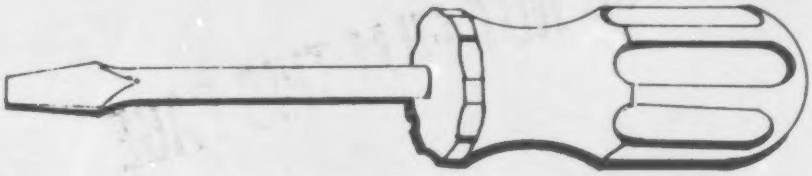

Oblique Cutting
With Skinning Holes


Curved Jaw

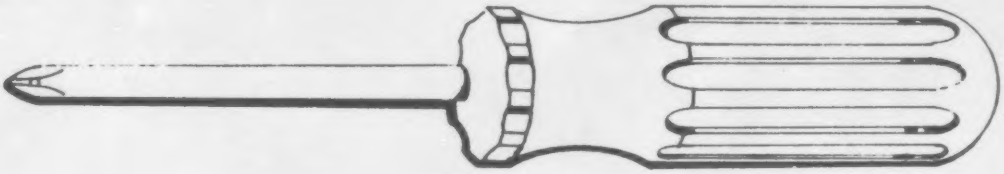

Vice-grips


Wire Stripper

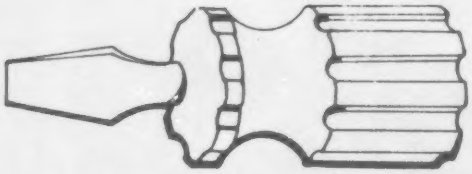
SCREWDRIVERS



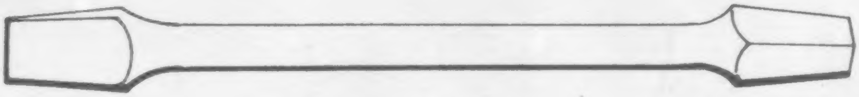
Conventional Straight Shank



Phillips

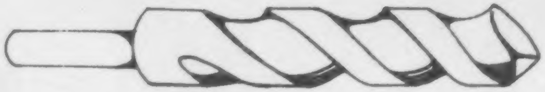


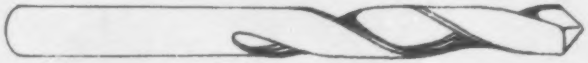
Stubb or Close Quarter

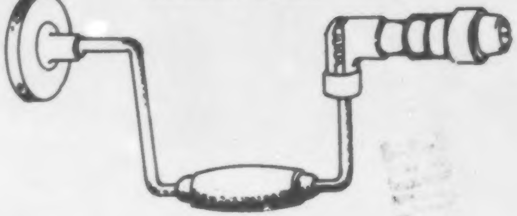


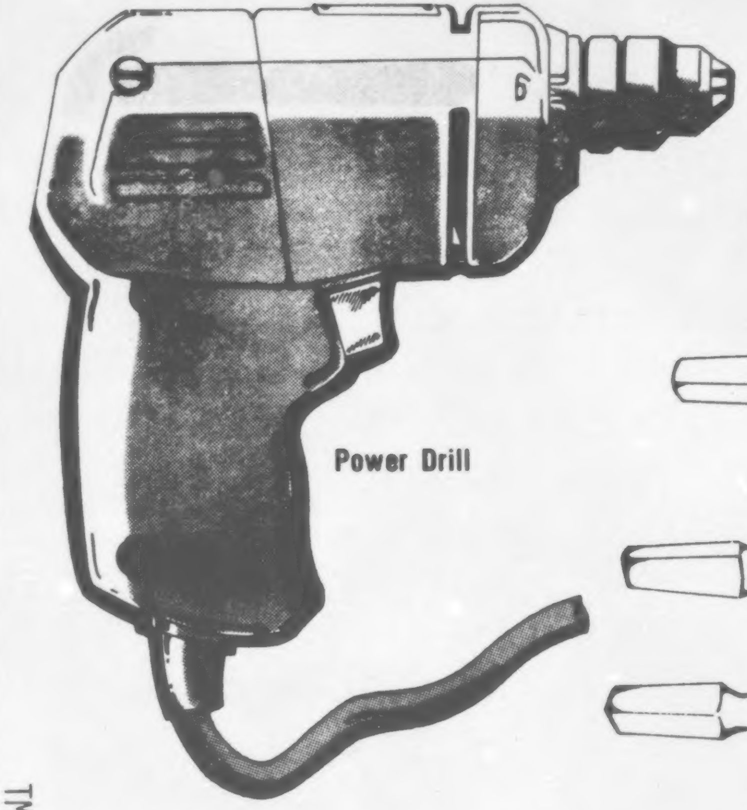
Screwdriver Bit

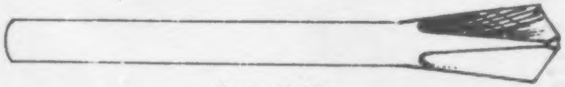
DRILLS AND BITS

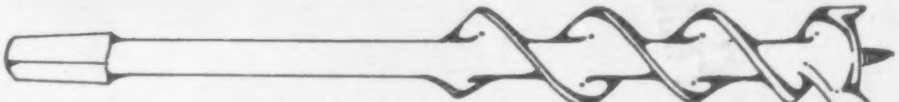

Masonry Bit

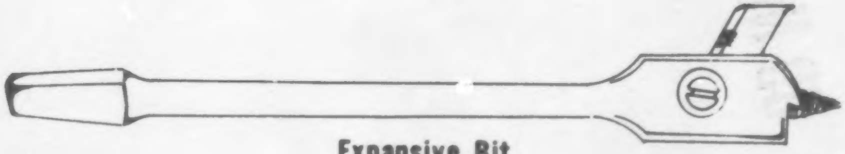

Twist Drill

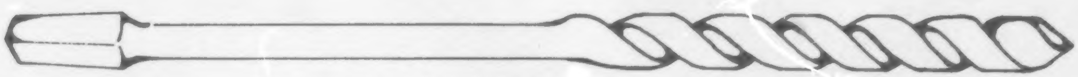

Ratchet Brace


Power Drill


Star Drills

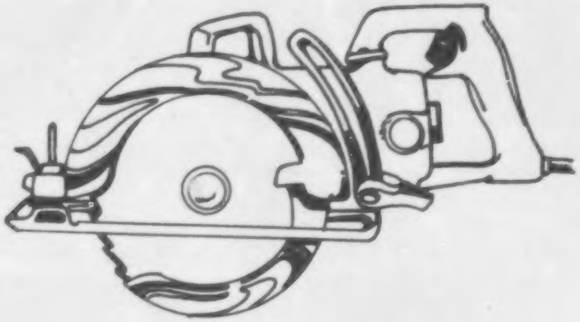

Auger Bit


Expansive Bit

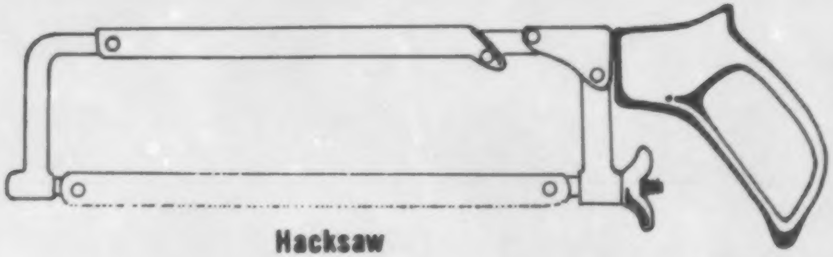

Wood Twist Bit

TM-13

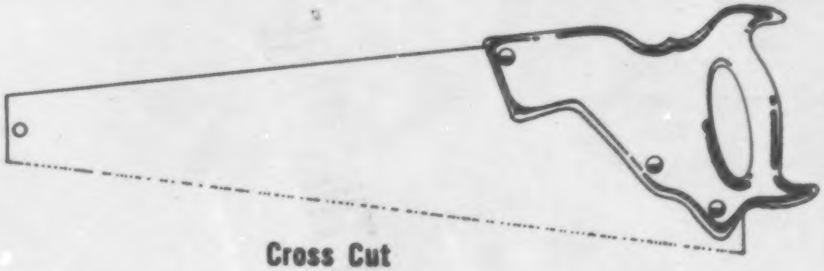
TYPES OF SAWS AND HAMMERS



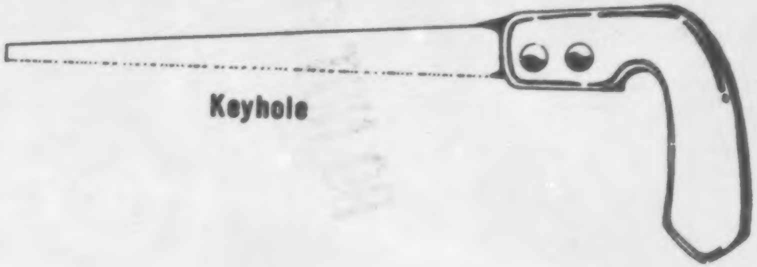
Power Saw



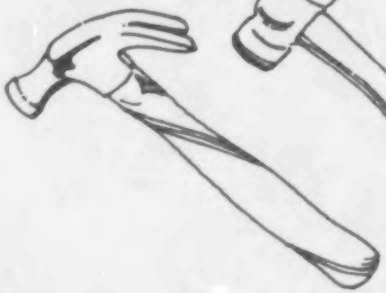
Hacksaw



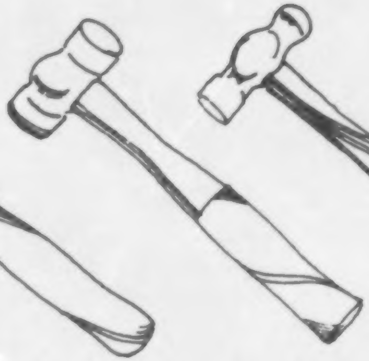
Cross Cut



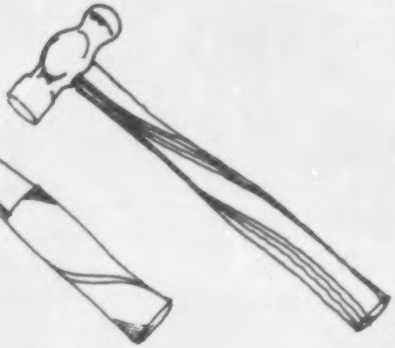
Keyhole



Claw Hammer



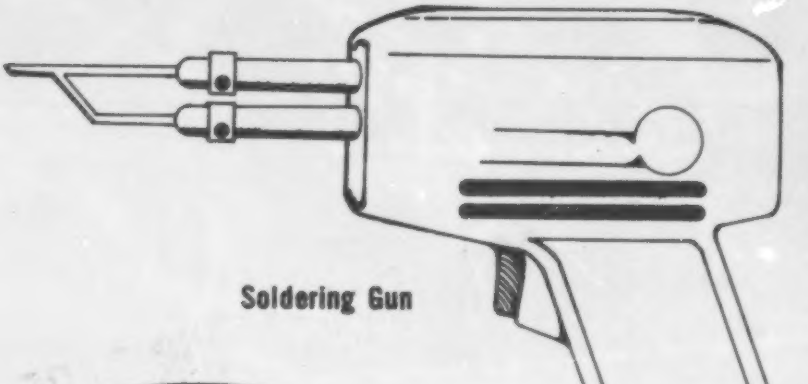
Lineman's Hammer



Ball Peen Hammer

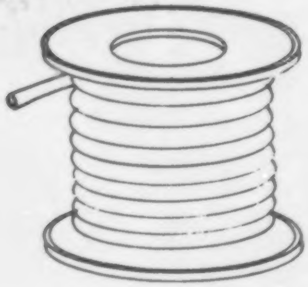
TM-14

SOLDERING EQUIPMENT

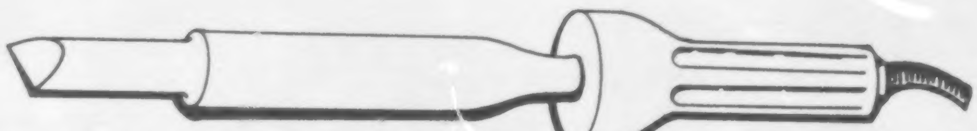


Soldering Gun

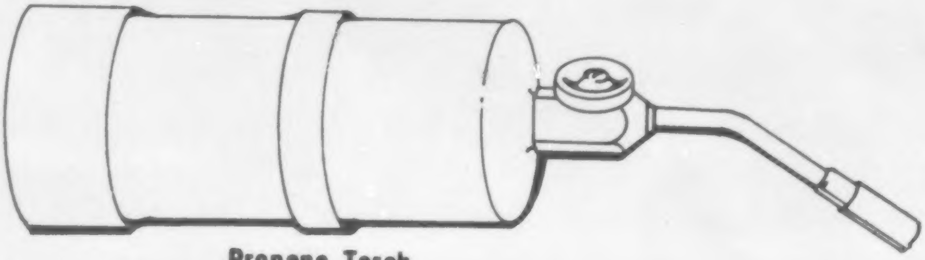
Soldering Paste



Solder

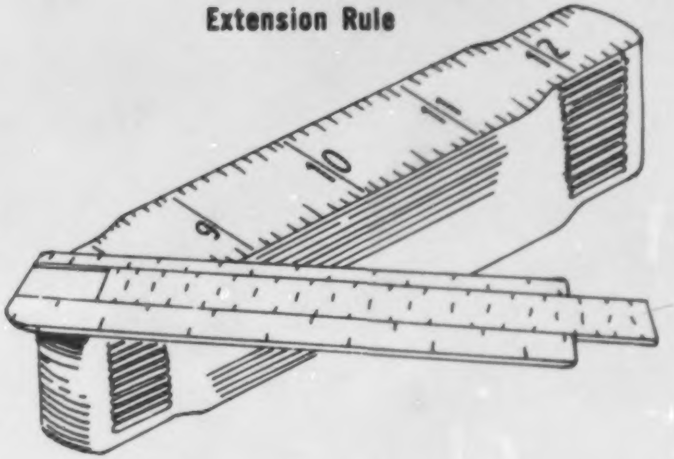


Electric Soldering Iron

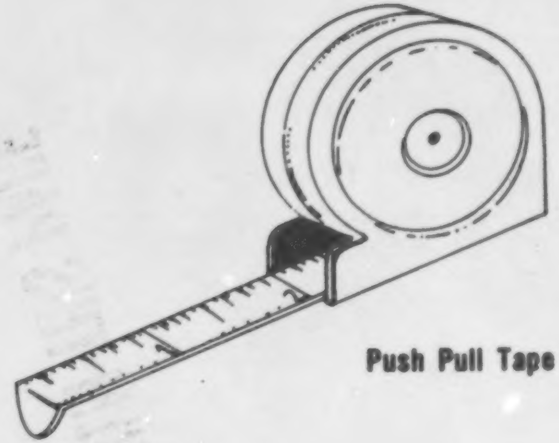


Propane Torch

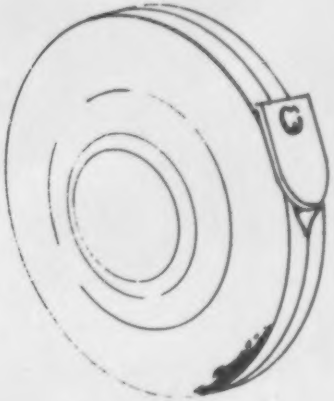
MEASURING DEVICES



Extension Rule

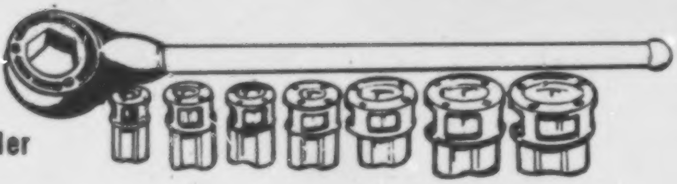


Push Pull Tape Rule

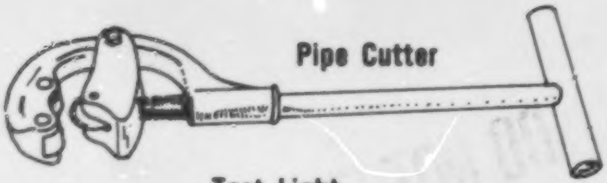


Steel Tape

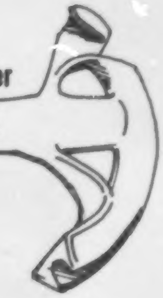
SPECIAL TOOLS AND EQUIPMENT


Hand Pipe Threader

Polyethylene Fish Tape

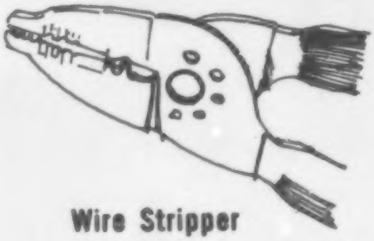

Pipe Cutter

Test Light


Conduit Bender

Wood Chisel

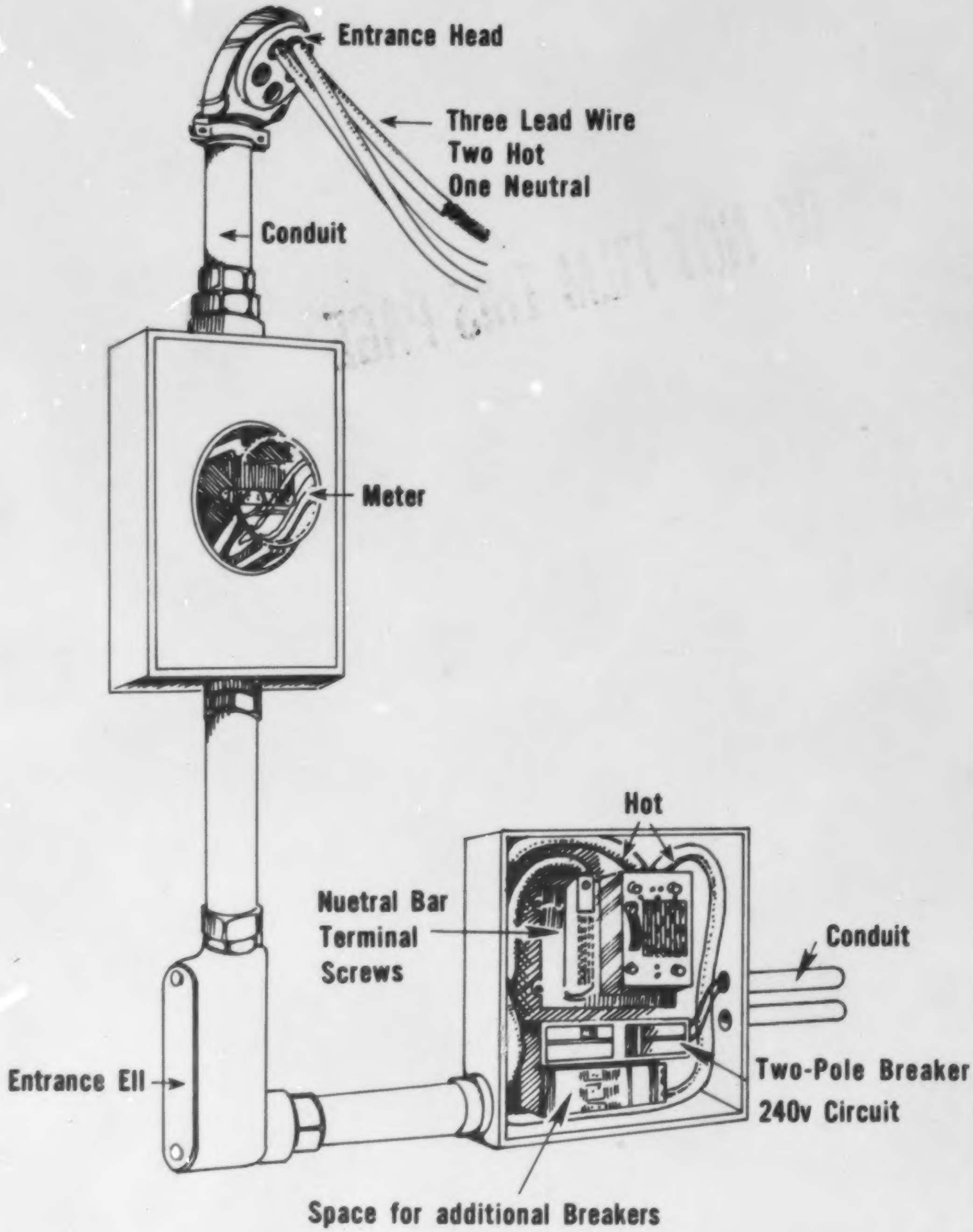
Wire Pulling Lubricant


Wire Stripper

Steel Fish Tape Reel and Puller

Utility Knife

ELECTRICAL SERVICE ENTRANCE



UNIT III

ELECTRICAL TOOLS AND MATERIALS

ASSIGNMENT SHEET 1--IDENTIFY ELECTRICAL CONDUCTORS

Directions: Identify each type of conductor pictured below. Write the name of each listed below in the correct blank.

Non-metallic cable with ground

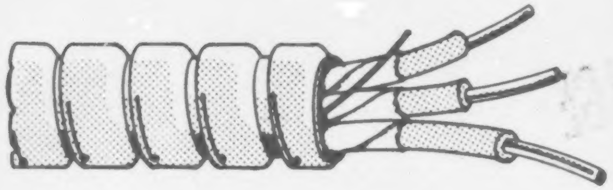
Lamp cord-braided

Power service cord-3 wire

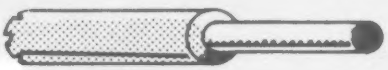
Metallic armored cable

Lamp cord (rubber covered)

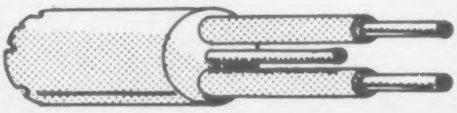
Thermal wire cable



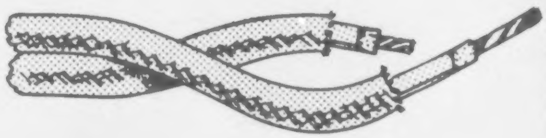
a. ______________________________



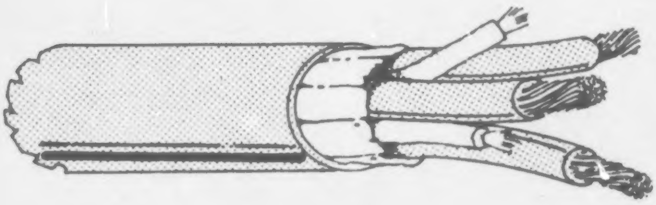
b. ______________________________



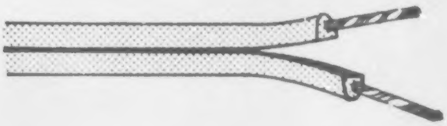
c. ______________________________



d. ______________________________



e. ______________________________



f. ______________________________

UNIT III

ELECTRICAL TOOLS AND MATERIALS

ASSIGNMENT SHEET 2--IDENTIFY ELECTRICAL TOOLS

Directions: The instructor will prepare a display of each tool listed in Part X of the Information Sheet. Each tool will be assigned a number only. On a sheet of paper, write the correct name of each tool beside the number of that tool.

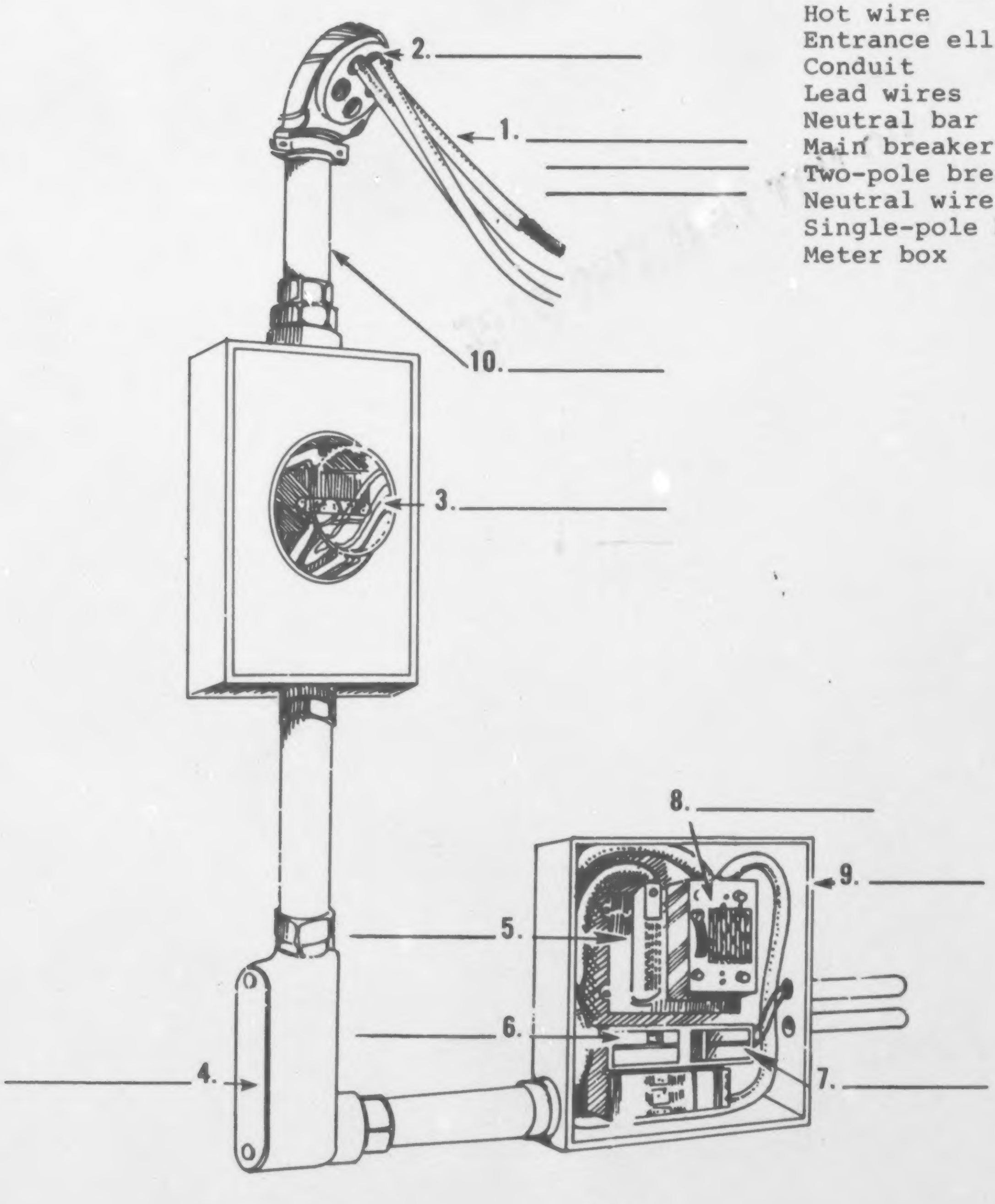
UNIT III

ELECTRICAL TOOLS AND MATERIALS

ASSIGNMENT SHEET 3--IDENTIFY ELECTRICAL SERVICE ENTRANCE PARTS

Directions: Using the illustration below and the information sheet, identify ten major parts of an electrical service entrance by writing the answer in the space provided.

Panel
Entrance head
Hot wire
Entrance ell
Conduit
Lead wires
Neutral bar
Main breaker
Two-pole breaker
Neutral wire
Single-pole breaker
Meter box



UNIT III

ELECTRICAL TOOLS AND MATERIALS

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

A. Metallic armored cable
B. Thermal wire cable
C. Non-metallic cable with ground
D. Lamp cord-braided
E. Power service cord-3 wires
F. Lamp cord (rubber covered)

Assignment Sheet 2

Evaluated to the satisfaction of the instructor.

Assignment Sheet 3

1. Lead wires
    a. Hot wire
    b. Neutral wire
2. Entrance head
3. Meter box
4. Entrance ell
5. Neutral bar
6. Single-pole breaker
7. Two-pole breaker
8. Main breaker
9. Panel
10. Conduit

UNIT III

ELECTRICAL TOOLS AND MATERIALS

UNIT TEST

1. Match the electrical terms on the right to the correct definition on the left by placing the number of the term in the blank at the left.

_____ a. Place in wiring system where appliances may be attached to the receptacle

_____ b. Metal or plastic pipe used to enclose conductors

_____ c. Device installed at outlet for connection of appliances

_____ d. Double receptacle

1. Outlet
2. Conduit
3. Receptacle
4. Adapter
5. Conductor
6. Duplex

2. Identify the correct types of wire conductors by placing a "✓" in the blank beside the proper terms only.

_____ a. Metallic armored cable (BX)

_____ b. Thermal wire cable (TW)

_____ c. Non-metallic cable (NM)

_____ d. Power service cord (SJ)

_____ e. Lamp cord (rubber or braided insulation)

3. Identify the correct types of conduit by placing a "✓" in the blank beside the proper terms only.

_____ a. Rigid

_____ b. Flexible

_____ c. Thickwall (EMT)

_____ d. Thinwall (EMT)

4. Select the correct types of electrical boxes by placing a "√" in the blank beside the proper terms only.

_____ a. Rectangular switch or outlet
_____ b. Octagonal ceiling or junction
_____ c. Sub mounted
_____ d. Shallow
_____ e. Waterproof

5. Identify the correct types of electrical connectors by placing a "√" in the blank beside the correct types only.

_____ a. Coupler
_____ b. Indenter type
_____ c. Wire nuts
_____ d. Soldered and taped
_____ e. Common type

6. Select the correct types of electrical covers by placing a "√" beside the correct terms only.

_____ a. Duplex
_____ b. Toggle switch
_____ c. Combination
_____ d. Hexagonal
_____ e. Specialty

7. List three types of switches.

a.
b.
c.

8. Select the correct types of electrical outlets and receptacles by placing a "√" in the blank beside the correct term only.

_____ a. 208-240V
_____ b. Duplex with ground
_____ c. Weatherproof
_____ d. Shockproof
_____ e. Duplex without ground

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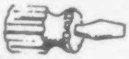
9. Identify which of the following electrical safety devices is a fuse type by placing a "✓" in the blanks beside your choice.

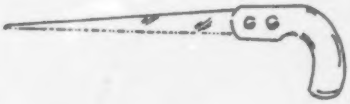
_____ a. Plug
_____ b. Blade
_____ c. Circuit breaker
_____ d. Cartridge
_____ e. Insert
_____ f. S type
_____ g. Time delay

10. Match the electrical tools on the left with the names on the right by placing the numbers on the right in the blanks on the left.

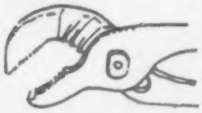
_____ a.



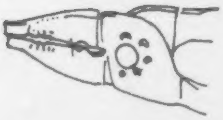
_____ b.



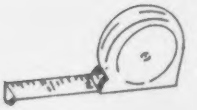
_____ c.



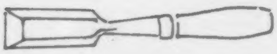
_____ d.



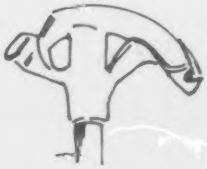
_____ e.



_____ f.



_____ g.



1. Lineman plier
2. Slip-joint plier
3. End cutters
4. Conduit bender
5. Channel lock pliers
6. Keyhole saw
7. Hack saw
8. Stubby screwdriver
9. Cold chisel
10. Steel tape
11. Wood chisel
12. Wire stripper
13. Phillips screwdriver
14. Folding rule
15. Fish tape

11. Select from the list below those items found in an electrical service entrance by placing a "✓" in the blank beside the correct answers.

_____ a. Neutral bar

_____ b. Main breaker

_____ c. Three-way switch

_____ d. Duplex outlet

_____ e. Meter box

_____ f. Entrance ell

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UNIT III

ELECTRICAL TOOLS AND MATERIALS

ANSWERS TO UNIT TEST

1.
1 a.
2 b.
3 c.
6 d.

2.
✓ a.
✓ b.
✓ c.
✓ d.
✓ e.

3.
✓ a.
✓ b.
______ c.
✓ d.

4.
✓ a.
✓ b.
______ c.
✓ d.
✓ e.

5.
✓ a.
✓ b.
✓ c.
✓ d.
______ e.

6.
✓ a.
✓ b.
✓ c.
______ d.
✓ e.

7. Any three of these four
1. Single pole
2. Three-way
3. Quiet
4. Mercury

8.
✓ a.
✓ b.
✓ c.
______ d.
✓ e.

9.
✓ a.
✓ b.
______ c.
✓ d.
______ e.

10.
8 a.
6 b.
5 c.
12 d.
10 e.
11 f.
4 g.

11.
✓ a.
✓ b.
______ c.
______ d.
✓ e.
✓ f.

UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

UNIT OBJECTIVE

After completing this unit, the student will be able to use a volt-ohm meter, and various other testing devices used in troubleshooting common electrical problems. This will be evidenced through demonstration and by satisfactorily completing a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Identify the parts of a volt-ohm meter.
2. Demonstrate the use of a volt-ohm meter.
3. Demonstrate the use of a neon tester.
4. Demonstrate the use of a continuity tester.

UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

A. Discuss unit objective with students.

B. Discuss each specific objective with the students and relate each one to electrical maintainance.

C. Organize the sequence of the objectives to fit shop organization and procedures.

D. Add any necessary objectives to fit local needs and program.

II. Information and Assignment Sheets

A. Use the information sheet to introduce terminology related to testing electrical equipment.

B. Discuss the various types of testing devices.

C. Use the assignment sheet to check the student's understanding of the material presented.

III. Transparency Masters

A. The transparency master is included in the student manual and may be used as an information sheet.

B. TM-1--THE VOLT-OHM METER shows the parts of this testing device.

IV. Job Sheets

(NOTE: Job sheets provide hands-on experiences for the students and do not require that answers be provided.)

A. JOB SHEET 1--USING THE OHM METER TO CHECK THE VOLTAGE AT AN OUTLET

B. JOB SHEET 2--USING THE OHM METER TO TEST A DRY-CELL BATTERY

C. JOB SHEET 3--USING THE NEON TESTER TO TEST A 120-VOLT CIRCUIT

D. JOB SHEET 4--USING THE CONTINUITY TESTER TO CHECK A HOUSE FUSE

V. Unit Evaluation

A. Have the students complete the unit test.

B. Check the student's answers and then discuss any areas in which the students appeared to lack understanding.

UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

INFORMATION SHEET

I. Terms and definitions

   A. Volt--A unit of measure of electrical pressure

   B. OHM--A unit of measure of electrical resistance

   C. Volt-ohm meter--A simple electrical measuring instrument used to troubleshoot electrical problems

   D. VAC--Volts alternating current

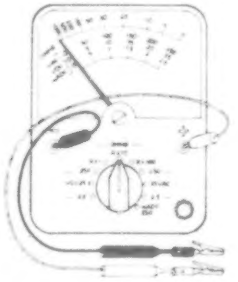
   E. VDC--Volts direct current

   F. MADC--Milliamps direct current

   G. Ohms scale--Low ohms readings are at right, high at left (TM-1) on the Volt-ohm meter

   H. ∞--Symbol meaning infinity

II. The Volt-ohm meter (TM-1)



   A. Ohms scale--Has low ohms readings at right, high at left--the reverse of other scales. Multiply ohms reading by whatever number selector switch indicates (RX10 or RX100). Symbol at left (∞) stands for infinity. When needle points to it, ohms reading is higher than meter can measure.

   B. VAC, VDC, and MADC scales--read here for volts AC, volts DC, or milliamps DC (thousandths of an ampere). Selector switch shows which set of numbers to use: top, middle, or bottom. When measuring unknown voltages, start with selector on the highest scale (250) and work down to achieve increased sensitivity and accuracy.

   C. Selector switch--rotate switch so that it points to quantity you want to measure. Instead of selector switch, some low-priced meters have an array of jacks, each one corresponding to a different measurement.

D. Test leads and jacks--Always insert black lead in - jack, red lead in + jack (--jack is also called com or common). When testing a battery or other DC voltage source, apply the black probe to negative terminal, red probe to positive terminal.

E. Pointer adjustment--Remove both probes from their jacks and check position of needle. It should point to zero volts. If it does not, turn pointer adjustment screw so that it does. If needle cannot be adjusted, meter is broken and should be sent to factory for repair.

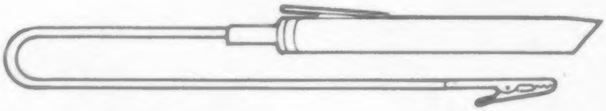
F. Ohms adjustment knob--Each time you turn the selector to an ohms position from another position, you must zero-adjust the ohms scale. Plug test leads into their jacks, hold or clip their probe ends firmly together, and turn Ω ADJ knob until needle reads zero ohms. Greek letter omega (Ω) is the symbol for ohms.

G. Test probes--In order to get correct readings on the volt-ohm meter, both probes must make firm electrical contact at the test points. Alligator type probes usually do this best; they also free your hands for manipulating parts during test. Needle-type probes may be required to get into tight spots or make contact with very small terminals. You can get alligator probes that slip over needle probes, or use two pairs of test leads--one with alligator probes, the other with needle probes.

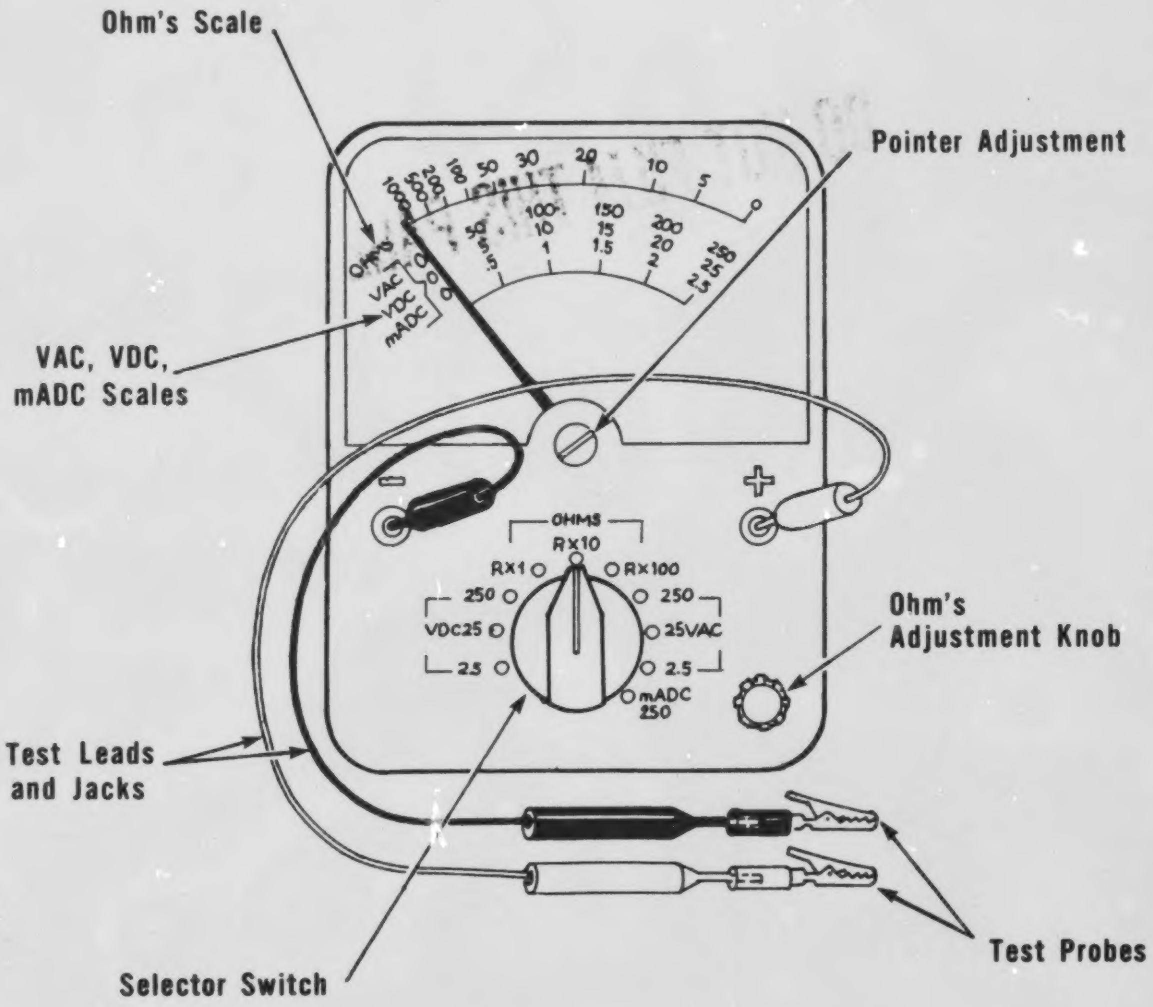
III. Other testing devices

A. Neon Tester determines the presence of voltage between 90 and 550 volts in a circuit.

B. Continuity Tester has a self-contained battery to test if a circuit is unbroken. It cannot be used on live circuits or interchanged with the neon tester.



THE VOLT-OHM METER

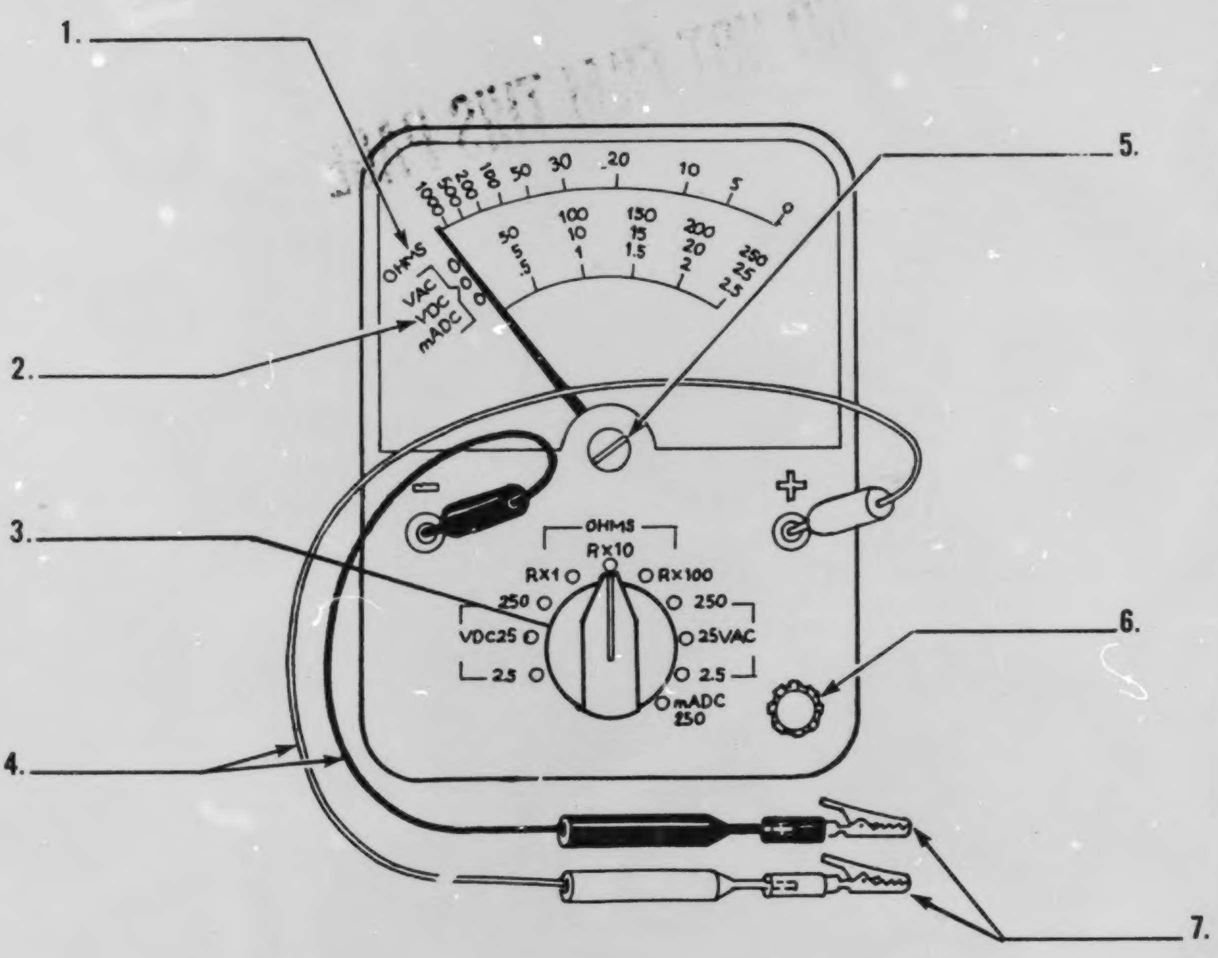


THE VOLT-OHM METER AND OTHER TESTING TOOLS

ASSIGNMENT SHEET - LIST THE PARTS OF A VOLT-OHM METER

Directions: Using the list below, identify the parts of a volt-ohm meter.

VAC, VDC, and MADC scales
Test leads and jacks
Selector switch
Ohms scale
Ohms adjustment knob
Pointer adjustment
Test probes



UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

ANSWERS TO ASSIGNMENT SHEET

1. Ohms scale
2. VAC, VDC, and MADC scales
3. Selector switch
4. Test leads and jacks
5. Pointer adjustment
6. Ohms adjustment knob
7. Test probes

THE VOLT-OHM METER AND OTHER TESTING TOOLS

JOB SHEET 1-USING THE VOLT-OHM METER TO TEST THE VOLTAGE AT A 125-VOLT WALL OUTLET

I. Tools and equipment

A. Volt-ohm meter

B. Safety glasses

C. 125-volt duplex grounded receptacle

II. Procedures

A. Cut off power to the outlet by removing fuse or switching OFF the circuit breaker.

B. Set the volt-ohm meter to the 250 VAC scale.

C. Insert needle probes into the slots of the wall receptacle.

D. Activate the outlet by replacing the fuse or throwing the circuit breaker on.

E. Read the volt-ohm meter. (Note: The meter should register between 100-150 VAC.)

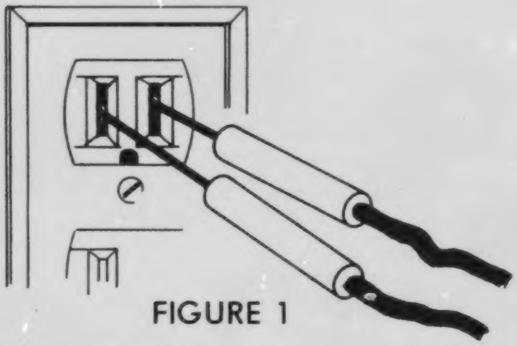


FIGURE 1

UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

JOB SHEET 2-USING THE VOLT-OHM METER TO TEST A DRY CELL BATTERY

I. Tools and materials needed

A. Volt-ohm meter

B. 1.5-volt battery from either a calculator or portable radio

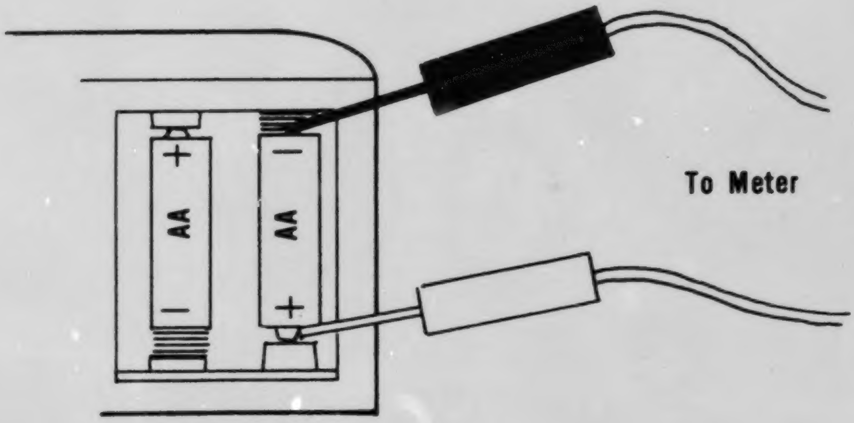
II. Procedures

A. Set the volt-ohm meter to the 2.5 VDC scale.

B. Touch the probes to the battery terminals (red probe to + and black to -).

C. Turn the unit ON. (Note: The battery must have an electrical load on it.)

D. The volt-ohm meter should read 1.5. (Note: If it falls below 1.3, the battery is dead.)



THE VOLT-OHM METER AND OTHER TESTING TOOLS

JOB SHEET 3-USING THE NEON TESTER TO TEST A 120-VOLT CIRCUIT

I. Tools and materials needed

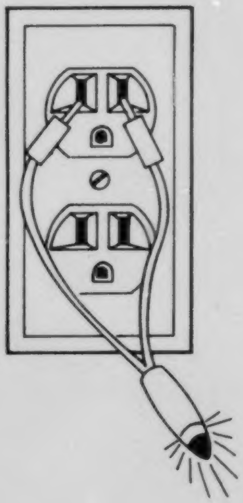
   A. Neon tester

   B. 120-volt outlet

II. Procedures

   A. Firmly press each lead of the tester into the receptacle slots to form a good electrical contact.

   B. If voltage is present, the neon will glow softly. (Note: This same test may be done with 240-volt circuit. The light will glow brighter.)



UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

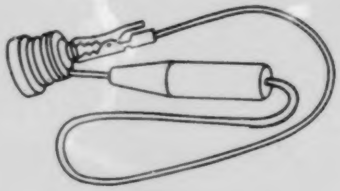
JOB SHEET 4-USING THE CONTINUITY TESTER TO CHECK A HOUSE FUSE

I. Tool and materials needed

- A. Continuity tester
- B. Fuse

II. Procedures

- A. Remove fuse from box with CAUTION.
- B. Apply probe of tester to metal bands of fuse.
- C. Apply alligator clip to center contact.



- D. Tester will light if fuse is good; it will stay dark if fuse is blown.

UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

UNIT TEST

I. Match the terms on the right to the correct definition on the left by placing the number in the blank.

_____ A. A unit of measure of electrical resistance

_____ B. Volts alternating current

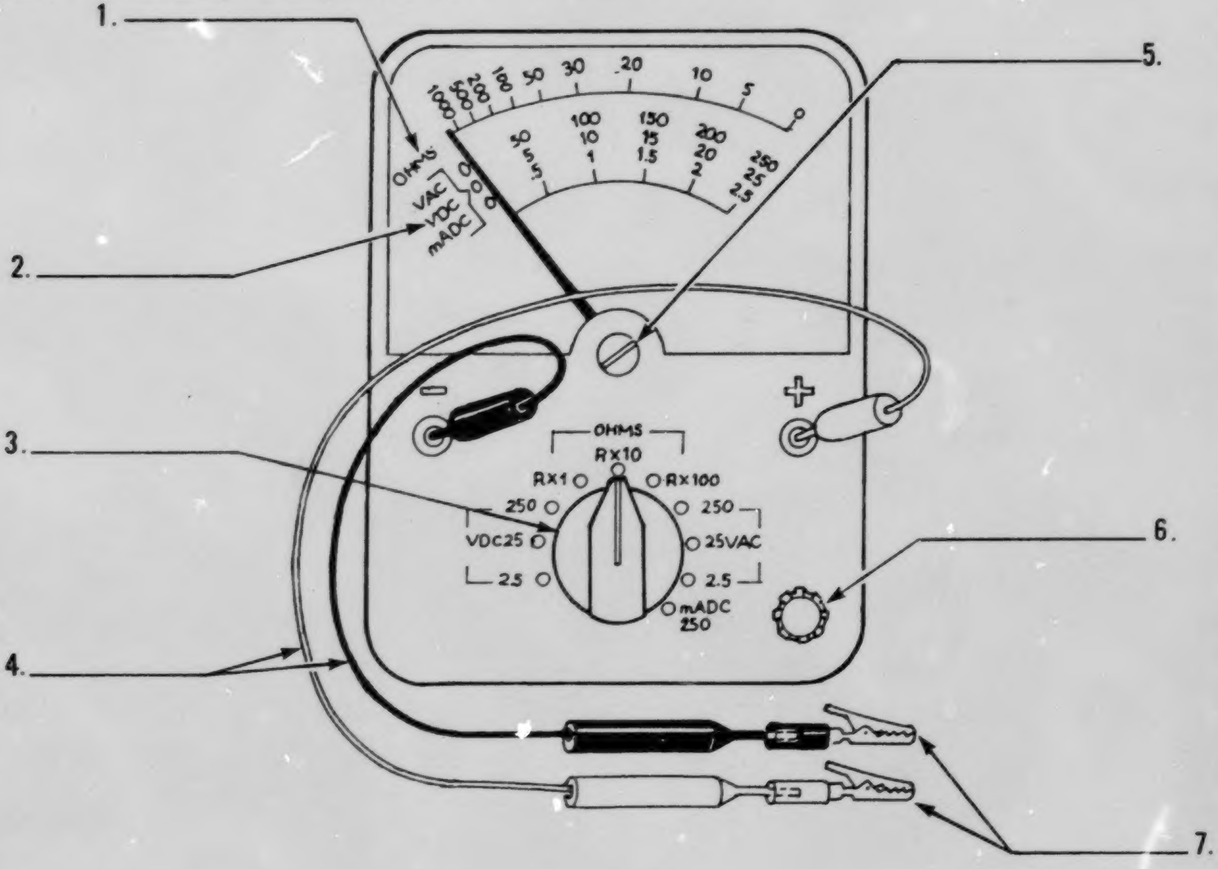
_____ C. An electrical measuring instrument used to troubleshoot electrical problems

_____ D. Symbol meaning infinity

_____ E. Has self-contained battery to test if circuit is unbroken

1. Continuity tester
2. ∞
3. Volt-ohm meter
4. Ohm
5. VAC

II. Identify the parts of a volt-ohm meter.



III. Demonstrate the ability to do the following:

A. Use a volt-ohm meter

B. Use a Neon tester

UNIT IV

THE VOLT-OHM METER AND OTHER TESTING TOOLS

ANSWERS TO TEST

I. 4 A.
5 B.
3 C.
2 D.
1 E.

II. 1. Ohms scale
2. VAC, VDC, MADC scales
3. Selector switch
4. Test leads and jacks
5. Pointer adjustment
6. Ohms adjustment knob
7. Test probes

III. Evaluated to the satisfaction of the instructor.

UNIT V

WIRING CIRCUITS

UNIT OBJECTIVE

After completing this unit, the student will be able to draw a wiring plan, identify electrical symbols, and select cable and entrance panel sizes. The student will also be able to perform wiring jobs according to correct procedures. This knowledge will be evidenced through demonstration and by satisfactorily completing the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match terms associated with planning a wiring layout to the correct definition.
2. Identify electrical symbols used in a wiring plan.
3. Point out the sizes of electrical cables.
4. Select the correct planning procedures for outlets and switches.
5. List three types of branch circuits.
6. Figure the number of branch circuits required for various wiring situations.
7. Select the proper entrance panel size.
8. Determine the service entrance cable size.
9. Match the terms associated with electrical wiring procedures to the correct definition.
10. Identify the correct splices and connections to use for each wiring procedure.
11. Identify the signs and reasons of wiring failure.
12. Demonstrate the ability to:
    a. Mount electrical boxes
    b. Install NM cable in electrical boxes
    c. Install duplex receptacles
    d. Install single-pole switches
    e. Install three-way switches
    f. Install a dimmer switch

UNIT V

WIRING CIRCUITS

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

  A. Discuss unit objective with students.

  B. Discuss the specific objectives with students and relate each objective to repair and maintenance of wiring circuits.

  C. Organize the sequence of the objectives to fit shop organization.

  D. Add any objectives necessary to fit local needs and program.

II. Information Sheets

  A. INFORMATION SHEET 1--PLANNING A WIRING LAYOUT

    1. Discuss with the students the importance of being careful in relation to safety.

    2. Stress how to identify signs of poor wiring when looking for the sources of wiring troubles.

  B. INFORMATION SHEET 2--ELECTRICAL WIRING PROCEDURES

III. Transparency Masters

  A. TM 1--Branch Circuits

  B. TM 2--Electrical Symbols

  C. TM 3--Planning Outlets and Switches

  D. TM 4--Never Locate Outlets Near Tub or Shower

  E. TM 5--Selecting Entrance Panel Size

  F. TM 6--Service Entry Panel

  G. TM 7--Duplex Receptacle

  H. TM 8--Single-Pole Switch

  I. TM 9--Dimmer Switch

IV. Assignment Sheets

- A. ASSIGNMENT SHEET 1--FIGURE GENERAL PURPOSE BRANCH CIRCUITS NEEDED
- B. ASSIGNMENT SHEET 2--DETERMINE ENTRANCE PANEL SIZE
- C. ASSIGNMENT SHEET 3--DRAW A WIRING PLAN

V. Job Sheets

- A. JOB SHEET 1--MOUNT ELECTRICAL BOXES
- B. JOB SHEET 2--INSTALL NON-METALLIC (NM) CABLE IN ELECTRICAL BOXES
- C. JOB SHEET 3--INSTALL DUPLEX RECEPTACLE
- D. JOB SHEET 4--INSTALL SINGLE-POLE SWITCH
- E. JOB SHEET 5--INSTALL THREE-WAY SWITCH
- F. JOB SHEET 6--INSTALL A DIMMER SWITCH

VI. Evaluation

- A. Give each part of the evaluation after completing the material it covers.
- B. Give the entire test at the end of the unit to determine if information is retained.
- C. Check the students' scores and review any problem areas.

VII. References

- A. Mix, Floyd. *House Wiring Simplified*. South Holland, IL: Goodheart-Wilcox Co., Inc., 1973.
- B. *General Construction Trades*. Stillwater, Oklahoma: State Department of Vocational and Technical Education, 1971.

UNIT V

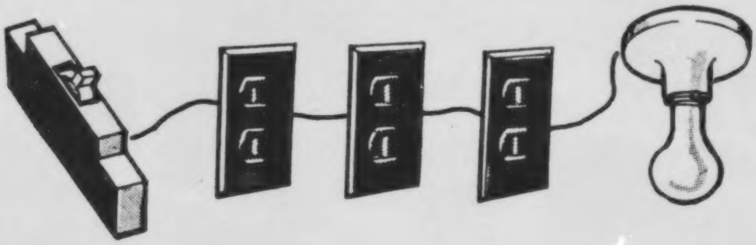
WIRING CIRCUITS

INFORMATION SHEET 1--PLANNING A WIRING LAYOUT

I. Terms and definitions

A. Branch circuit--All the outlets and receptacles connected on one breaker (TM-1)

(NOTE: Commonly called a "leg")

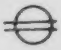


B. Breaker--A safety switch that connects the branch circuit to the power source

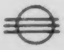
C. Special purposes outlet--Any outlet for appliances that uses 240-volts, or motors larger than 1/3 horsepower

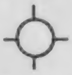
D. Wiring plan--A drawing of the house floor plan showing switch wiring and outlets

II. Symbols used in wiring plans (TM-2)

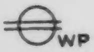
A. Duplex receptacle outlet- 

B. Special purpose outlet-

C. 240 volt outlet- 

D. Ceiling light outlet- 

E. TV outlet- $\boxed{\text{TV}}$

F. Weatherproof duplex outlet- 

G. Single pole switch- S

H. Three-way switch- S_3

I. Switch wiring- S———

INFORMATION

III. Selecting wire size

A. Electrical wire varies from No. 40 to No. 4/0 or 0000.

(NOTE: The larger the gauge number, the smaller the wire diameter.)

B. Reading wire sizes

1. The first number is the gauge (size) of the wire
2. The second number shows how many conductors are in the wire

Example: 12/3 = 12 gauge, 3 conductors

C. Amp rating for wires

Wire Size (Gauge)	Amp Rating
14	14
12	20
10	30
8	40
6	50
4	70
2	95
1	110
1/0 or 0	215
2/0 or 00	145
4/0 or 0000	195

Iv. Planning outlets and switches (TM-3)

A. Living room, bedroom, den or dining room

1. One or more ceiling lights controlled by a wall switch
2. Duplex outlets on walls, to be no more than 6 feet apart

B. Kitchen

1. One or more ceiling lights controlled by wall switch
2. One light over sink, with wall switch
3. Special purpose outlet for dishwasher, disposal, and refrigerator
4. Special purpose outlet for electric range
5. Duplex outlets spaced every 4 feet in work area and 12 feet apart in remainder of kitchen

C. Laundry and utility room

1. One or more ceiling lights controlled by wall switch

2. Grounded duplex outlets

3. Special purpose outlets for dryer, water heater, electric furnace, or air conditioner

D. Bathroom (TM-4)

1. One or more lighting outlets located near mirror, with wall switch

2. Duplex receptacles near mirror

CAUTION: Never locate duplex receptacles or switches where they can be reached from tub or shower.

E. Halls

1. One ceiling light controlled by three-way wall switch

2. One duplex outlet every 12 feet

F. Stairways and closets

1. One light for each landing, controlled by three-way switch

2. One ceiling light for each closet

G. Exterior entrances

1. At least one light for each entrance, controlled by inside switch

2. One duplex weatherproof receptacle at front and back entrances

H. Garage

1. At least one ceiling light, controlled by three-way switch

2. At least two duplex outlets on rear and side walls

3. One duplex outlet in ceiling for door closer

V. Types of branch circuits

A. General purpose--20 amp

B. Small appliance--20 amp

C. Special purpose individual outlet--50 amp

VI. Figure branch circuits needed

A. General purpose 20 amp branch circuits

1. One branch circuit for each 500 square feet of floor space

2. Nine outlets per general purpose circuit

3. Add total number of outlets, divide by 9, counting any fraction as a whole

   Example:

   A house has 30 general purpose outlets. To find the number of general purpose branch circuits needed:

   30 ÷ 9 = 3.3, or 4 circuits needed

   (NOTE: Do not count small outlets on small appliance circuits.)

B. Small appliance branch circuits
   1. Three circuits per house
   2. Three outlets for each circuit
   3. Used in kitchen, laundry room, and dining room

C. Special purpose individual circuits
   1. One circuit for each outlet
   2. 240-volt outlets
   3. 1/3 horsepower or larger

VII. Selecting entrance panel size (TM-5 and TM-6)

A. Standard size panels
   1. 100 amp

      (NOTE: 100 amp is minimum size allowed.)
   2. 125 amp
   3. 150 amp
   4. 200 amp

B. Determine size needed by adding all wattage, dividing by volts of service equals amps

   Example: Total wattage of all circuits = 20,000 watts

   House has 240-volt service

   20,000 ÷ 240v = 83.3 amps

   House needs 100 amp panel

C. Each branch circuit requires a breaker switch in panel

D. Each 240v circuit requires two breaker switches

E. Leave a minimum of four open circuits for future needs

VIII. Determine service entrance cable size

A. 100 amp panel-use 1/0

B. 150 amp panel-use 2/0

C. 200 amp panel-use 4/0

UNIT V

WIRING CIRCUITS

INFORMATION SHEET 2--ELECTRICAL WIRING PROCEDURES

I. Terms and definitions

A. Wire--A single conductor

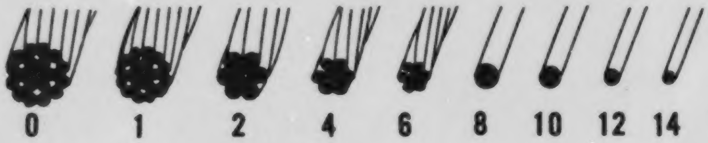
B. Electrical cable--Two or more wires put together inside an insulating cover

C. Cord--Several small wires put together in an insulating cover; is usually very flexible

D. Wire size--Measure of wire diameter and called the "gauge" of wire

E. Wire gauge number--The number that determines the size of the wire from 4/0 to 14

(NOTE: The smaller the number, the larger the wire diameter.)



F. Ground wire--Usually bare or green wire that connects circuit to earth for safety

G. Hot wire--Usually black, but can be any color except green and always has voltage applied to it

CAUTION: Assume all wires to be HOT when checking a circuit.

H. Neutral wire--Usually white, and serves as a return for current

I. Junction box--A covered outlet box used to enclose splices within a circuit

J. Outlet box--A box used to bring the wires to a switch, receptacle, or light

K. Terminal--A connection between the wires and electrical devices usually fastened with a screw or clip

L. Duplex receptacle--A contact device that is installed at an outlet for connection of two single plugs

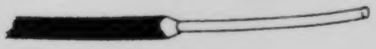
M. Single-pole switch--A switch that controls a circuit in one place

N. Three-way switch--A switch to control a circuit in two places

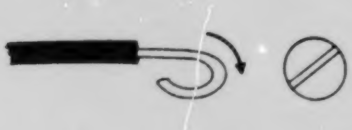
O. NM--Non-metallic cable

II. Splices and connections

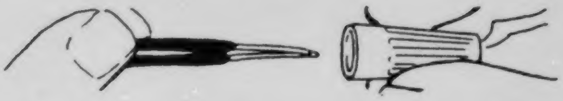
A. Insulation removal



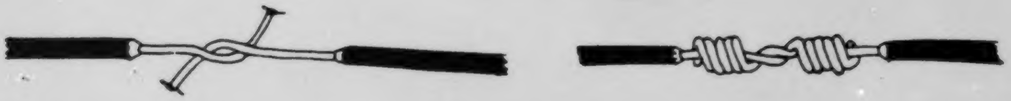
B. Terminal loop



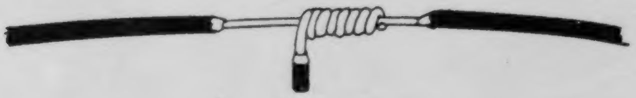
C. Solderless connection using wire nut



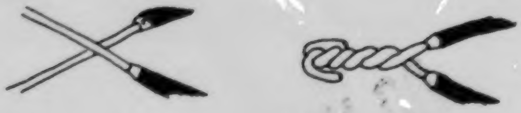
D. Splicing two wires



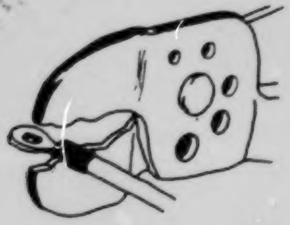
E. Tap splice



F. Pigtail splice



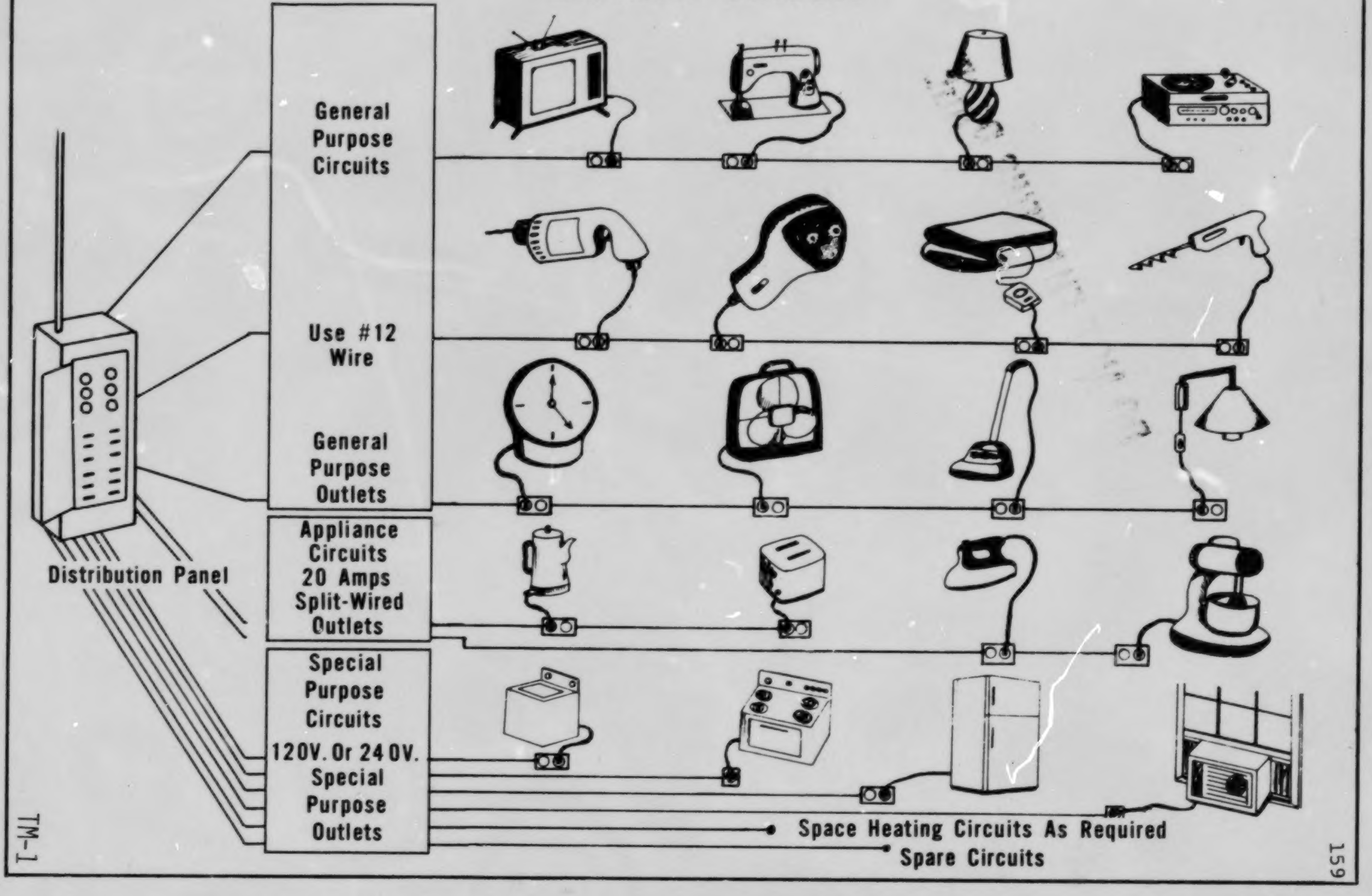
G. Solderless terminal



III. Signs of poor wiring

- A. Blown fuse
- B. Tripped circuit breaker
- C. Flickering or dim lights
- D. Poorly-operating appliances
- E. Heat--hot wires, cords, or outlets
    - 1. Overloaded circuits
    - 2. Breaker or fuse too small
    - 3. Shorted circuit
    - 4. Loose or broken wires
    - 5. Faulty equipment

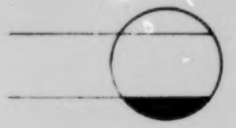
BRANCH CIRCUIT



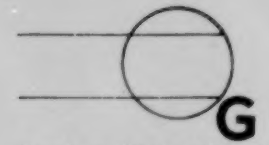
TM-1

159

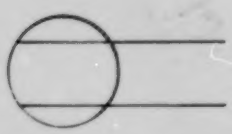
ELECTRICAL SYMBOLS



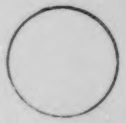
Duplex Convenience Outlet-Split Wired



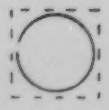
Duplex Grounding Outlet



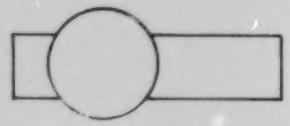
Duplex Convenience Outlet



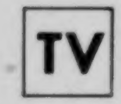
Lighting Outlet



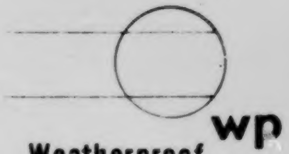
Ceiling Lighting Outlet



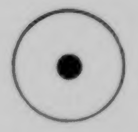
Fluorescent Lighting



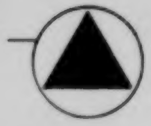
Television Outlet



Weatherproof Duplex Outlet



Floor Outlet



Special-Purpose Outlet

S

Single-Pole Switch

S_3

Three-Way Switch

S_4

Four-Way Switch

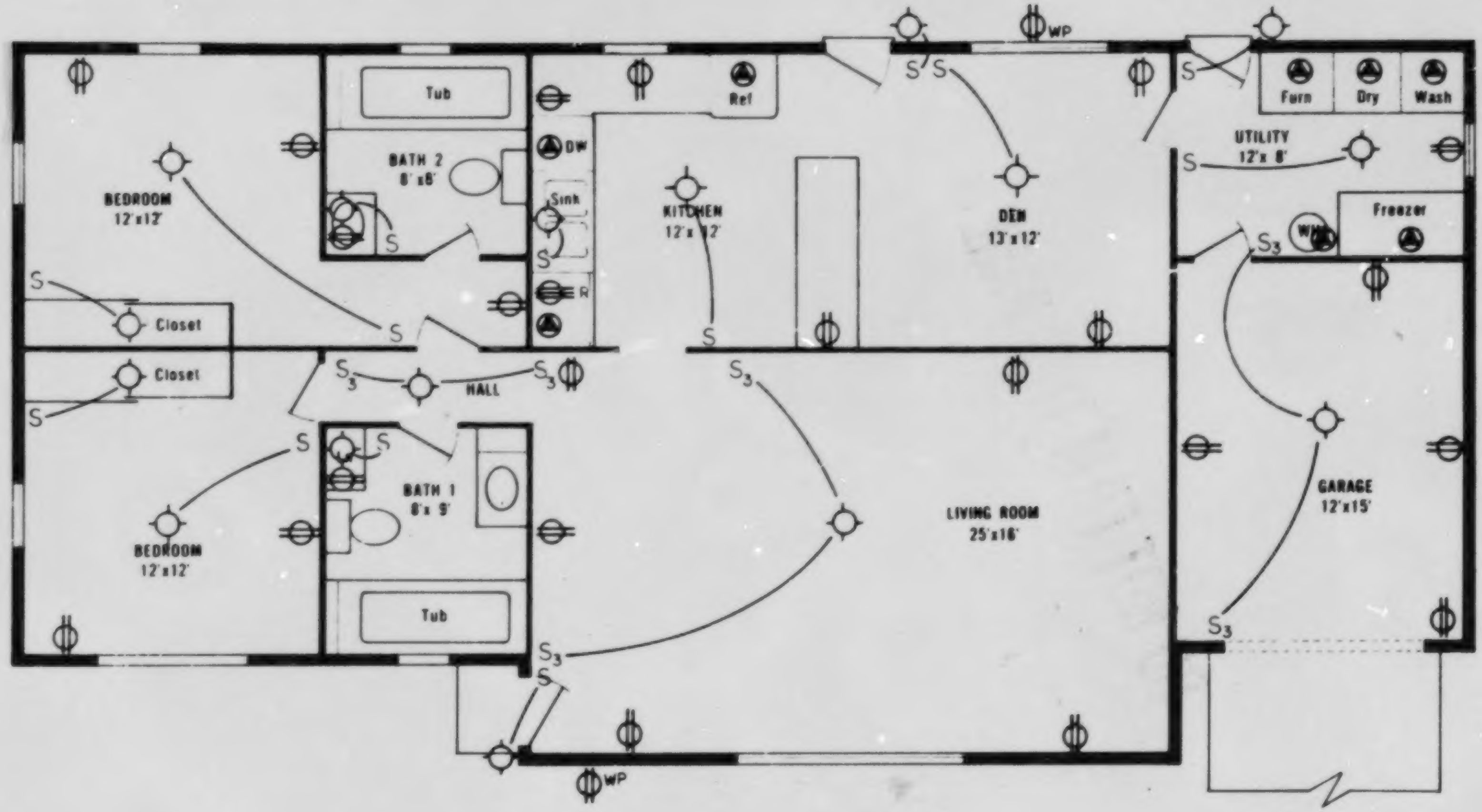
S_p

Switch And Pilot

S_w

Weatherproof Switch

PLANNING OUTLETS AND SWITCHES

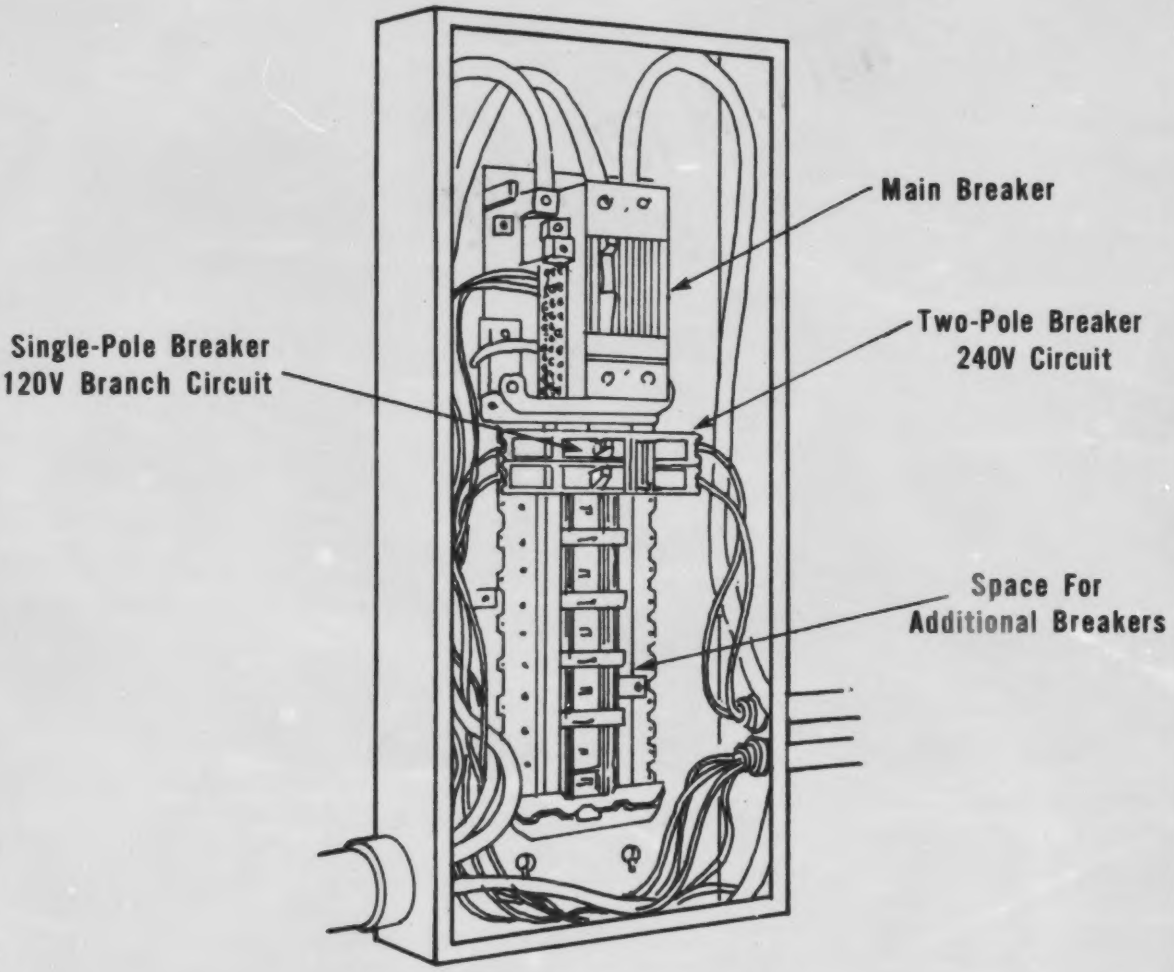


TM-3

NEVER LOCATE OUTLETS NEAR TUB OR SHOWER

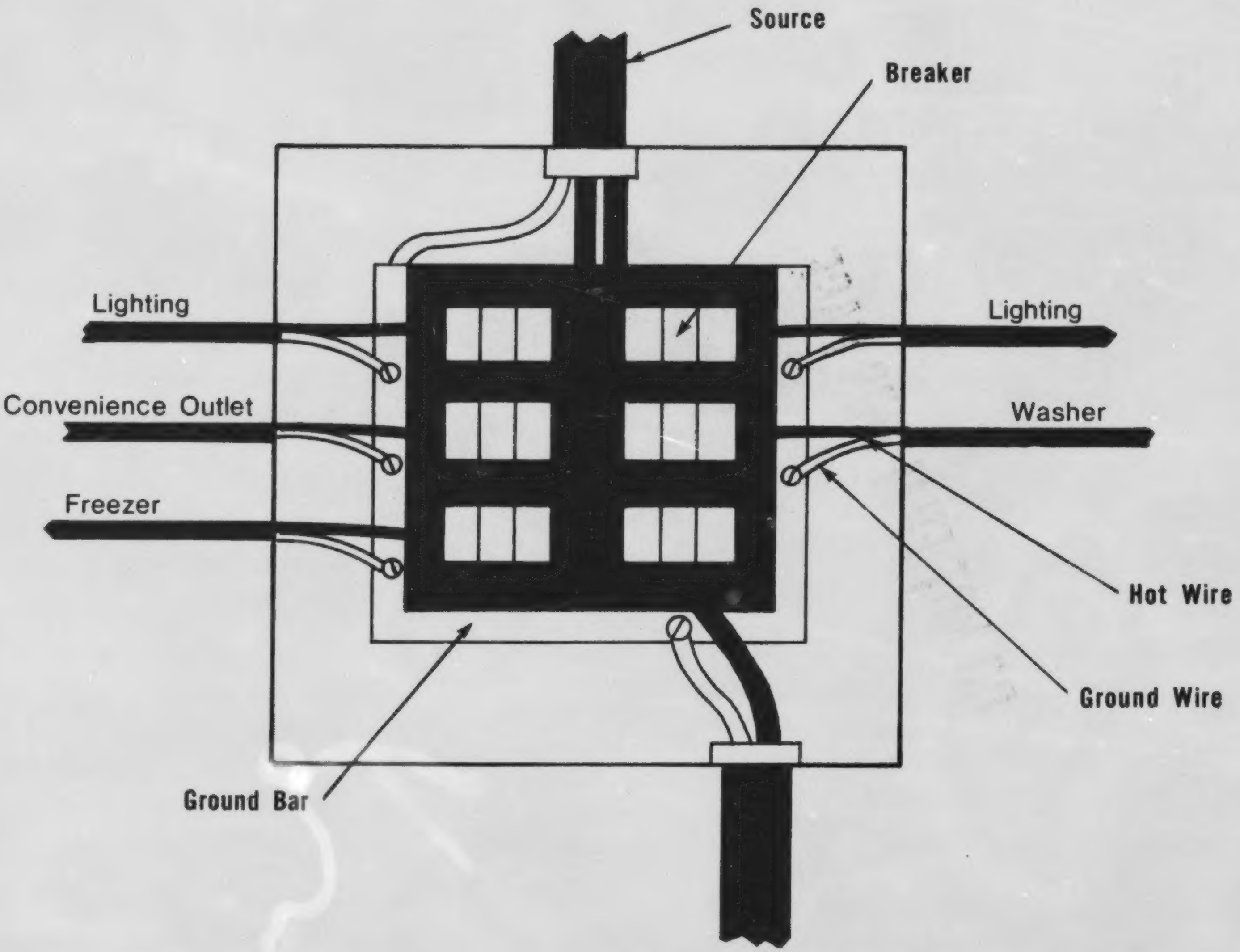
TM-4

SELECTING ENTRANCE PANEL SIZE


Main Breaker
Two-Pole Breaker 240V Circuit
Single-Pole Breaker 120V Branch Circuit
Space For Additional Breakers

Service Entrance, 200-Ampere Capacity

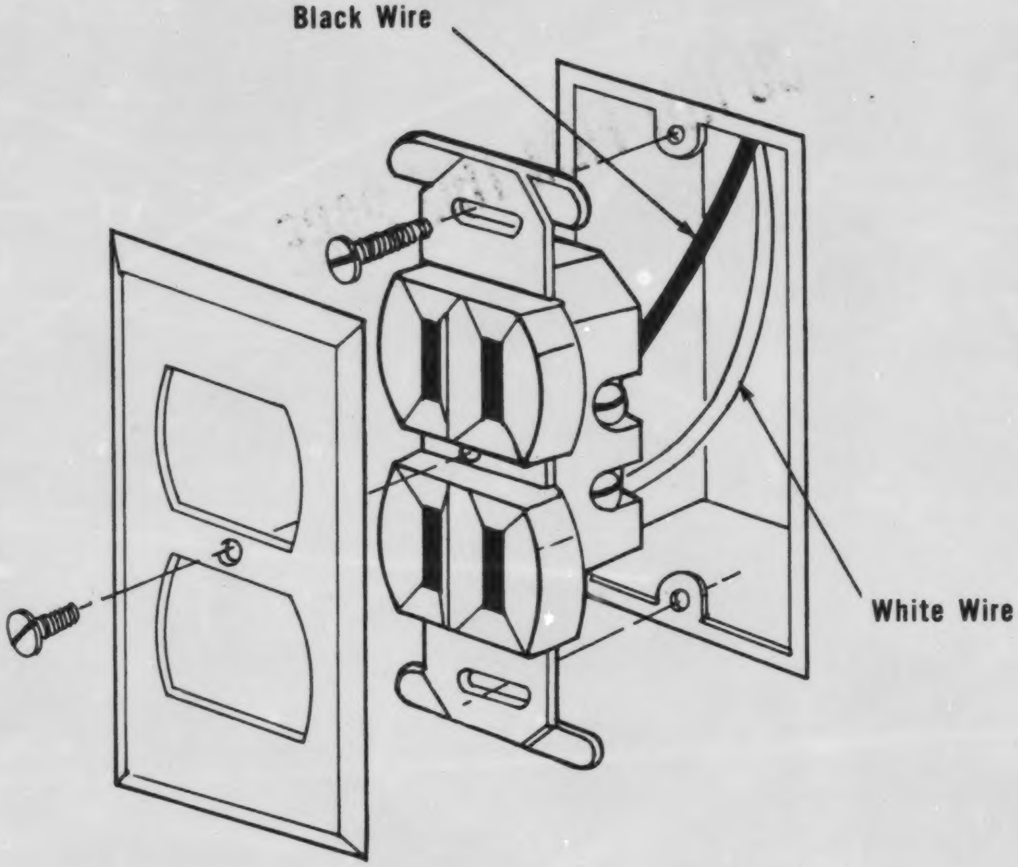
SERVICE ENTRANCE PANEL



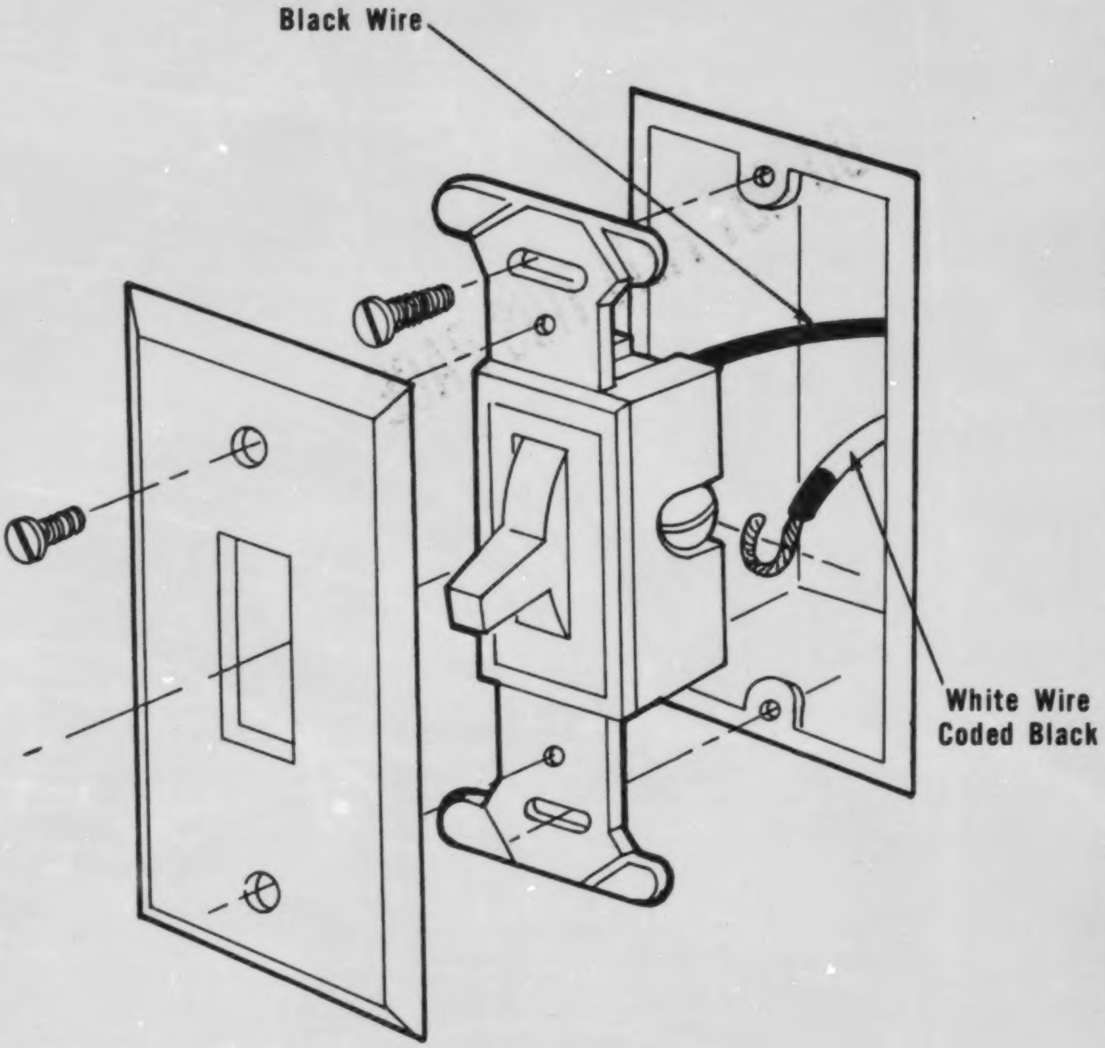
TM-6

169

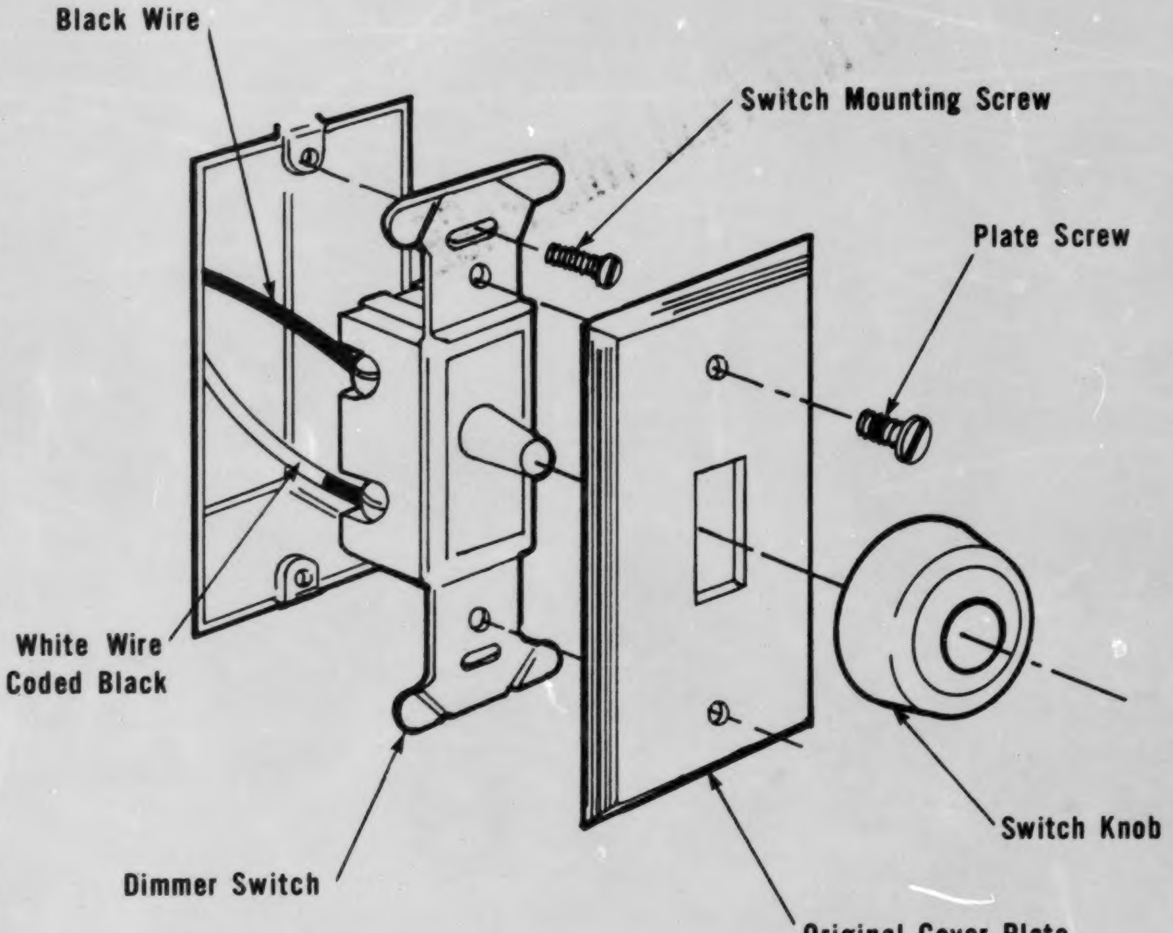
DUPLEX RECEPTACLE



SINGLE-POLE SWITCH



DIMMER SWITCH



UNIT V

WIRING CIRCUITS

ASSIGNMENT SHEET 1--FIGURE GENERAL PURPOSE BRANCH CIRCUITS NEEDED

Directions: Using the information given, figure the number of general purpose circuits the house will need.

House has 42 general purpose outlets
No more than 9 outlets per circuit

A. ___________ number of outlets

B. ÷___________ number of outlets allowed per circuit

C. =___________ number of circuits

Remember: Any fraction of a number counts as one circuit.

So 4.6 circuits

D. =___________ actual number of general purpose circuits

UNIT V

WIRING CIRCUITS

ASSIGNMENT SHEET 2--DETERMINE ENTRANCE PANEL SIZE

Directions: Using the information below, determine what size entrance panel is needed for each problem.

A. 16,000 watts is total wattage of all circuits
120-volt service to house

1. ____________ total watts of circuits
2. ÷____________ service voltage
3. =____________ amps
4. so: ______ amp panel is the size needed

(NOTE: Panel should have a higher amp rating than total amps used.)

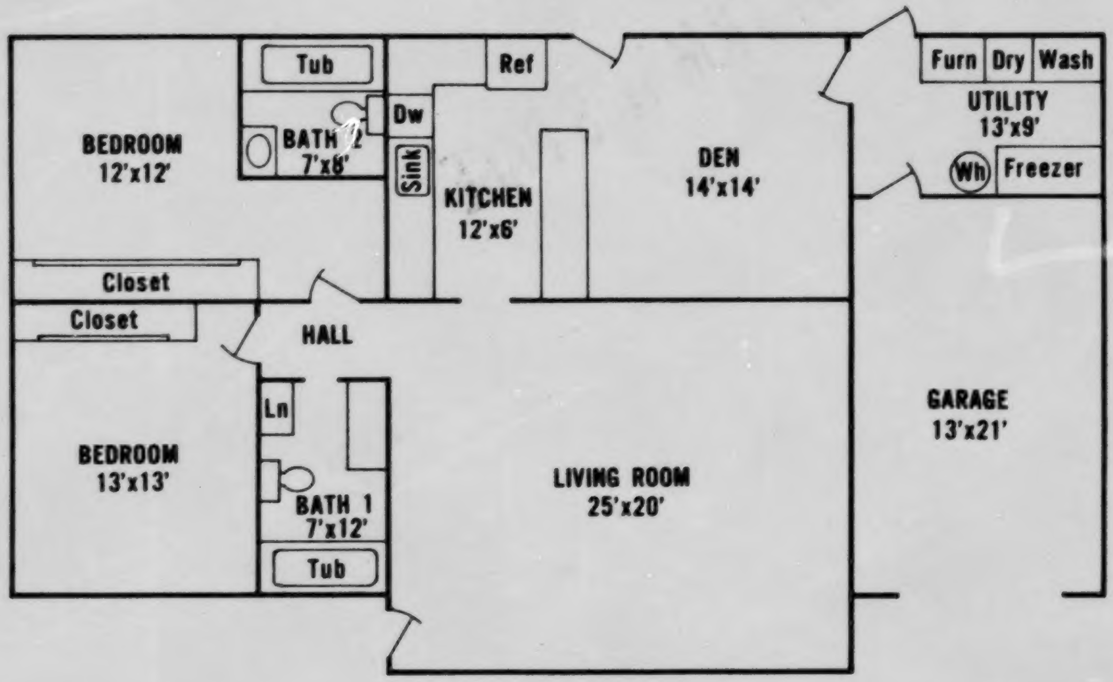
B. 40,000 watts is total wattage of all circuits
240-volt service to house

1. ____________ total watts of circuits
2. ÷____________ service voltage
3. =____________ amps
4. so: ______ amp panel is needed

WIRING CIRCUITS

ASSIGNMENT SHEET 3--DRAW A WIRING PLAN

Directions: Draw a wiring plan on the floor plan below. Put in all outlets, lights, switches, and special purpose outlets. Use the information sheet to help determine how many outlets, what type switches, and other help you may need.



UNIT V

WIRING CIRCUITS

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

A. 42 number of outlets
B. 9 number of outlets allowed per circuit
C. 4.6 number of circuits
D. 5 acutal number of general purpose circuits

Assignment Sheet 2

A. 1. 26,000 total wattage of circuits
2. 120V service voltage
3. 133.3 amps
4. 150 amp panel needed

B. 1. 40,000 total wattage of circuits
2. 240V service voltage
3. 166.6 amps
4. 200 amp panel needed

Assignment Sheet 3

Evaluated to the satisfaction of the instructor.

UNIT V

WIRING CIRCUITS

JOB SHEET 1--MOUNT ELECTRICAL BOXES

I. Tools and materials

   A. Outlet box

   B. Junction box

   C. Claw hammer

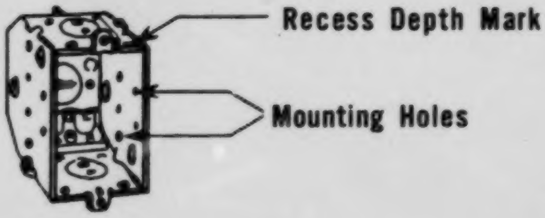
   D. 16 d box nails

II. Procedure

   A. Locate desired position of outlet box

   B. Locate box mounting holes and recess depth mark on box

   (NOTE: Recess depth mark is a slight indention approximately 1/4 inch from box opening.



   C. Decide which nail holes should be used

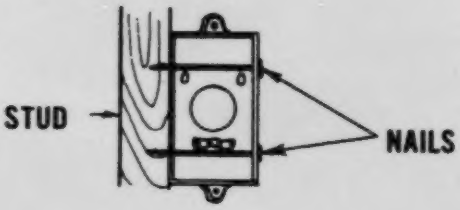
   D. Hold box in desired position, with recess depth mark even with edge of stud

   E. Drive nails through holes into stud until nails are snug against the box

   F. Check box to be sure it is held tightly in place

   G. Repeat steps A through F for mounting junction box

   Example:



   H. Have instructor check your work

   I. Clean work area

   J. Store tools properly

WIRING CIRCUITS

JOB SHEET 2--INSTALL NON-METALLIC (NM) CABLE IN ELECTRICAL BOXES

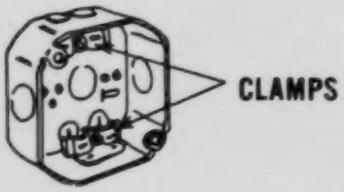
I. Tools and materials

- A. Lineman pliers
- B. Conventional screwdriver
- C. 12/2 NM cable with ground wires
- D. 2 NM cable connectors
- E. Brace and 3/4-inch bit

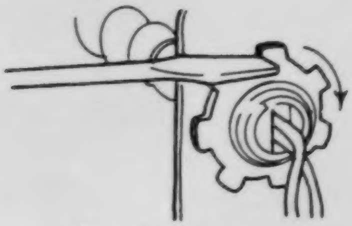
II. Procedure

- A. Use mounted boxes from Job Sheet 1
- B. Remove knockout from electrical boxes
- C. Remove locknut from connectors

(NOTE: Boxes may have clamps for holding cable inside and connectors may not be necessary.)



- D. Insert connector in knockout hole
- E. Screw locknut on connector
- F. Tighten locknut with screwdriver



G. Drill holes through studs for cable run between boxes

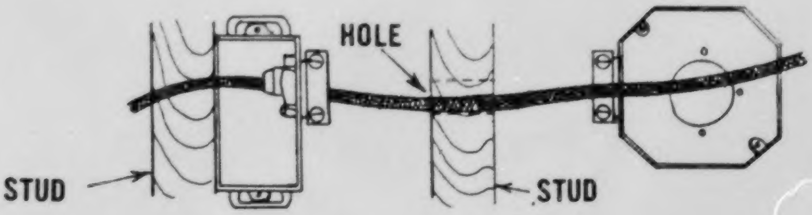
H. Slide cable through connectors and holes to connect boxes

I. Have a minimum of 7 inches extending from each box

J. Cut the cable to length

K. Tighten screws on connectors

Example:



L. Have instructor check your work

M. Clean work area

N. Store tools properly

UNIT V

WIRING CIRCUITS

JOB SHEET 3--INSTALL DUPLEX RECEPTACLE

I. Tools and materials

- A. Wire stripper
- B. Utility knife
- C. Conventional screwdriver
- D. Long nose pliers
- E. Duplex receptacle

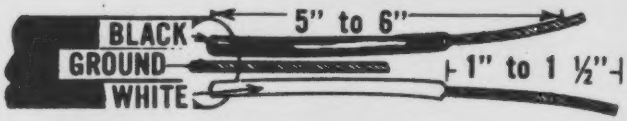
II. Procedures

A. Remove about 6 inches of outside insulation from the end of the cable with the utility knife

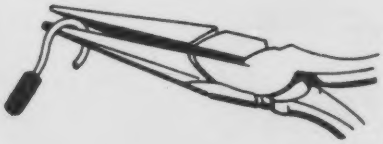
CAUTION: Do not cut the insulation on the wires under the outside insulation.

B. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper

(NOTE: Be sure to use the proper gauge hole on the stripper.)



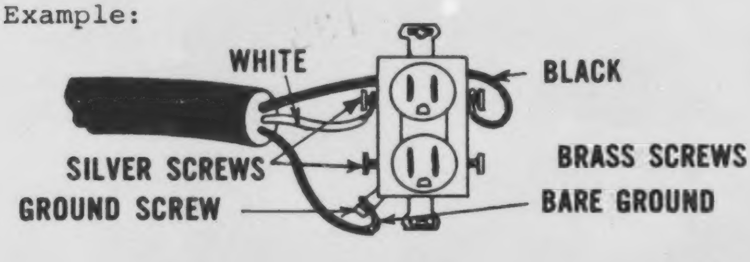
C. Make a loop on the end of each wire using the long nose pliers



D. Using the screwdriver, attach the wires to the receptacle as shown below

(NOTE: Be sure the wire loop is on the screw in the clockwise position.)

Example:



E. Mount receptacle in outlet box
F. Tighten mounting screws
G. Have instructor check your work
H. Clean work area
I. Store tools properly

WIRING CIRCUITS

JOB SHEET 4--INSTALL SINGLE-POLE SWITCH

I. Tools and materials

- A. Wire stripper
- B. Utility knife
- C. Conventional screwdriver
- D. Single-pole switch
- E. Long nose or chair nose pliers

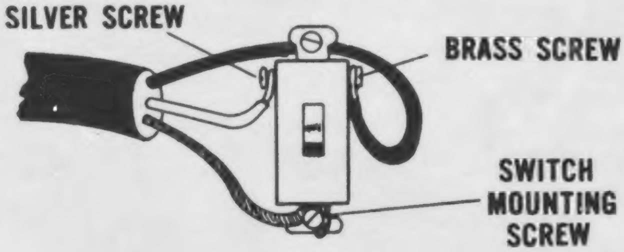
II. Procedures

- A. Use cable at junction box end of Job Sheet 2
- B. Remove about 6 inches of outer insulation from the end of the cable using utility knife

  (NOTE: Do not cut the insulation on the wires under the outside insulation.)
- C. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper

  (NOTE: Be sure to use the proper gauge hole on the stripper.)
- D. Make a loop on the end of each wire using the long nose or chair nose pliers
- E. Attach wires to the switch as shown below

  Example:



- F. Connect ground wire behind switch mounting screw
- G. Have instructor check your work
- H. Clean work area
- I. Store tools properly

WIRING CIRCUITS

JOB SHEET 5--INSTALL THREE-WAY SWITCH

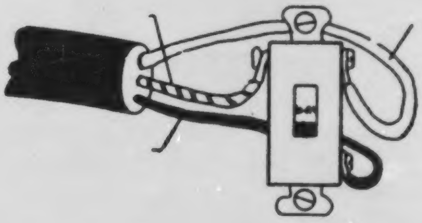
I. Tools and materials

- A. Utility knife
- B. Wire stripper
- C. Conventional screwdriver
- D. Three-way switch
- E. Three-wire NM cable
- F. Chair nose or long nose pliers

II. Procedures

- A. Strip 6 inches of outer insulation off cable with utility knife
- B. Strip 1 1/2 inches off end of each wire
- C. Make loop on end of each wire
- D. Connect wires to switch as shown below

  Example:



- E. Have instructor check work
- F. Clean work area
- G. Store tools properly

UNIT V

WIRING CIRCUITS

JOB SHEET 6--INSTALL A DIMMER SWITCH

I. Tools and materials

- A. Wire stripper
- B. Utility knife
- C. Conventional screwdriver
- D. Dimmer switch
- E. Long nose or chair nose pliers

II. Procedures

- A. Use cable at junction box end of Job Sheet 2
- B. Remove about 6 inches of outer insulation from the end of the cable using utility knife

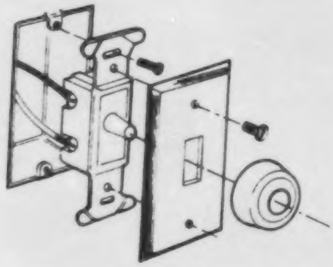
  (NOTE: Do not cut the insulation on the wires under the outside insulation.)

- C. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper

  (NOTE: Be sure to use the proper gauge hole on the stripper.)

- D. Make a loop on the end of each wire using the long nose or chair nose pliers
- E. Attach wires to the switch as shown below

  Example:



- F. Connect ground wire behind switch mounting screw
- G. Have instructor check your work
- H. Clean work area
- I. Store tools properly

UNIT V

WIRING CIRCUITS

TEST PART I

1. Match the electrical terms on the right to the correct definition on the left by placing the number in the blank.

_____ a. A safety switch that connects the branch circuits to the power source

_____ b. All the outlets and receptacles connected on one breaker

_____ c. Any outlet for appliances that use 240-volts or motors larger than 1/3 horsepower

_____ d. A drawing of the house floor plan showing switch wiring and outlets

1. Branch circuit
2. Conduit
3. Wiring plan
4. Adapter
5. Breaker
6. Special purpose outlets

2. Identify the electrical symbols on the right by placing the number of each beside the blanks on the left.

_____ a. Switch wiring

_____ b. Three-way switch

_____ c. Single-pole switch

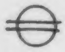
_____ d. Weatherproof duplex outlet

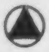
_____ e. Ceiling light outlet

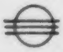
_____ f. 240-volt outlet

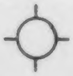
_____ g. Special purpose outlet

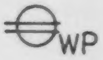
_____ h. Duplex receptacle outlet

1. 

2. 

3. 

4. 

5. 

6. S

7. S_3

8. S ————

3. Identify the size of the cables below by writing the two numbers in the blank that describe each wire.

Example: 18/3 g. 18 gauge, 3 conductors

_____ a. 14 gauge, 2 conductors

_____ b. 10 gauge, 3 conductors

_____ c. 12 gauge, 3 conductors

_____ d. 16 gauge, 2 conductors w/ground

4. Identify the correct planning of outlets and switches by placing an "✓" in the blank beside correct statements only.

_____ a. At least one ceiling light in living room or bedroom

_____ b. Duplex outlets every 4 feet in work area of kitchen

_____ c. Put outlets near tub in bathroom

_____ d. Range in kitchen should be a special purpose outlet

5. List the three types of branch circuits.

a.

b.

c.

6. Figure the number of branch circuits needed with the information below.

A house has 32 general purpose outlets

_____ a. number of outlets

9 number of outlets per circuit

=_____ b. number of circuits

So:_____ c. is actual number of branch circuits

7. Select the proper entrance panel size for each of the amps below. Choose one of the four standard sizes of 100, 125, 150, or 200 amp panel.

_____ a. 85 amps used by house

_____ b. 134 amps used by house

_____ c. 169 amps used by house

_____ d. 101 amps used by house

8. Determine the service entrance cable size for each of the panels below.

_____ a. 100 amp panel

_____ b. 150 amp panel

_____ c. 200 amp panel

UNIT V

WIRING CIRCUITS

TEST PART II

1. Match the terms at the right to the correct definitions on the left by placing the number in the blank.

_____ a. All the outlets and receptacles connected on one leg

_____ b. A single conductor

_____ c. Usually bare or green wire that connects circuit to earth for safety

_____ d. Several small wires put together in an insulating cover and usually very flexible

_____ e. Usually black but can be any color except green and always has voltage applied

_____ f. Usually a white wire and serves as a return for current

_____ g. Measure of wire diameter and called the "gauge" of wire

_____ h. A covered outlet box used to enclose splices within a circuit

_____ i. A drawing of the house floor plan showing wiring

_____ j. A connection between the wires and electrical devices usually fastened with a screw or clip

1. Outlet box
2. Junction box
3. Hot wire
4. Wire size
5. Cord
6. Electrical cable
7. Wire
8. Ground wire
9. Neutral wire
10. Terminal
11. Three-way switch
12. Wiring plan
13. Branch circuit
14. Duplex receptacle
15. Single-pole switch

2. Identify the splices and connections below by placing the letter of each description in the blank beside its drawing.

_____ a.

_____ b.

_____ c.

_____ d.

_____ e.

_____ f.

1. Wire nut
2. Solderless terminal
3. Pigtail splice
4. Tap splice
5. Terminal loop
6. Two-wire splice

3. Identify the signs and reasons for wiring failure by placing a "✓" in the blank beside the correct term.

_____ a. Blown fuse
_____ b. Tripped circuit breaker
_____ c. Burned out bulbs
_____ d. Flickering and dim lights
_____ e. Poorly operating appliances
_____ f. Overload circuits
_____ g. Shorted circuits
_____ h. Broken or loose wires
_____ i. Faulty equipment

UNIT V

WIRING CIRCUITS

ANSWERS TO TESTS

Part I

1.
5 a.
1 b.
6 c.
3 d.

2.
8 a.
7 b.
4 c.
3 d.
2 e.
5 f.
6 g.
1 h.

3.
14/2 a.
10/3 b.
12/3 c.
16/2 d.

4.
____ a.
____ b.
____ c.
____ d.

5.
a. General purpose
b. Small appliance
c. Special purpose
(Note: In any order)

6.
2 a.
3.5 b.
4 c.

7.
100 a.
150 b.
200 c.
125 d.

8.
1/0 a.
2/0 b.
4/0 c.

Part II

1.
13 a.
7 b.
8 c.
5 d.
3 e.
9 f.
4 g.
2 h.
12 i.
10 j.

2.
6 a.
4 b.
3 c.
1 d.
5 e.
2 f.

3.
✓ a.
✓ b.
____ c.
✓ d.
✓ e.
✓ f.
✓ g.
✓ h.
✓ i.

UNIT VI

TROUBLESHOOTING

UNIT OBJECTIVE

After completion of this unit, the student will be able to troubleshoot a defective receptacle, switch, fuse/breaker, and be able to identify the hot wire. The knowledge will be evidenced through demonstration and by satisfactorily completing the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define troubleshooting.
2. List nine troubleshooting procedures.
3. Discuss each troubleshooting procedure.
4. Demonstrate the ability to troubleshoot a receptacle.
5. Demonstrate the ability to troubleshoot a switch.
6. Demonstrate the ability to locate the hot wire in a switch, receptacle, or light fixture.
7. Demonstrate the ability to check for a defective fuse/breaker.

UNIT VI

TROUBLESHOOTING

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

A. Discuss the unit objective with the students.

B. Discuss each of the specific objectives with the students and relate them to troubleshooting electrical problems.

C. Organize the sequence of the objectives to fit local shop organization and procedures.

D. Add any objectives necessary to fit local needs and program.

II. Information Sheet

A. Use the information on this sheet to introduce basic troubleshooting procedures.

B. Caution the students as each procedure is discussed that the instructor MUST be present when they are performing any of the jobs given.

III. Transparency Masters

(NOTE: No transparency masters are included in this unit, but illustrations are provided on each job sheet to show what is to be done.

IV. Job Sheets

A. JOB SHEET 1--CHECKING FOR A DEFECTIVE RECEPTACLE

B. JOB SHEET 2--CHECKING FOR A DEFECTIVE SWITCH

C. JOB SHEET 3--CHECKING FOR THE HOT WIRE

D. JOB SHEET 4--CHECKING FOR A DEFECTIVE CIRCUIT BREAKER

E. JOB SHEET 5--CHECKING FOR A DEFECTIVE FUSE

F. Unit Test

G. Answers to Unit Test

V. Unit Evaluation

A. Give the unit test.

B. After checking the test results, discuss any areas that gave students trouble in answering.

VI. References

A. Rockis, Gary. Residential Wiring, American Technical Society, Chicago, IL. 1978.

B. Taylor, Mark, Residential Wiring, Stillwater, OK: State Department of Vocational and Technical Education, 1978.

UNIT VI

TROUBLESHOOTING

INFORMATION SHEET

I. Terms and definitions

  A. Troubleshooting--The process of locating malfunctions in machines and electrical equipment.

II. Basic troubleshooting procedures

  A. Turn off power.

  B. Understand the system.

    1. Know the system's physical parts.

    2. Know the system's voltage and other information.

    3. Try to trace out circuits mentally and physically if possible.

  C. Ask the owner or a person familiar with the system about the problem.

    1. Ask about symptoms.

    2. Ask about maintenance.

    3. Ask if problem has happened before.

  D. Inspect the system.

    1. Smell for unusual odors.

    2. Look for frayed cords.

    3. Look for loose plugs and loose receptacles.

    4. Feel for heat.

    5. Look for burned marks, discolorations.

    6. Watch for improperly installed or connected appliances.

  E. Operate system, if safely possible.

    1. Check voltages.

    2. Turn off switches.

    3. Unplug appliances.

    4. Inspect the system as listed.

  F. List possible problem causes.

  G. Reach a conclusion mentally.

  H. Test conclusion physically and, above all, safely.

  I. Repair system, if possible.

  J. Replace, if necessary.

UNIT VI

TROUBLESHOOTING

JOB SHEET 1--CHECKING FOR A DEFECTIVE RECEPTACLE

I. Tools and materials

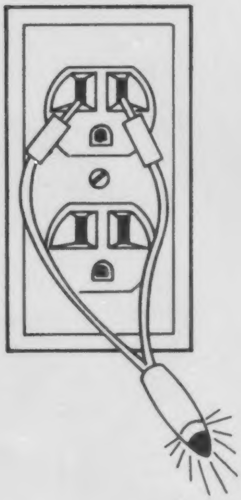
- A. Neon Tester
- B. Receptacle

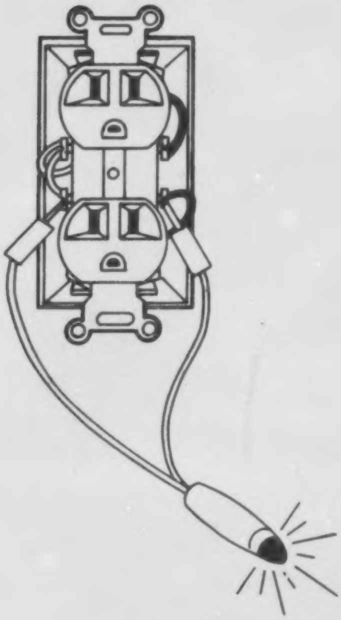
II. Procedure

CAUTION: Instructor MUST be present.

A. Press each lead of the neon tester into the receptacle slots.

If voltage is present, the neon will glow softly. If there is not any voltage, there will be no light in the tester.





B. If there is no light, remove the receptacle cover.

C. Carefully check the voltage at the receptacle terminals.

1. If voltage is present at the terminals, but not at the receptacle, replace receptacle.
2. If there is no voltage at the terminals, check breakers and/or fuses.

UNIT VI

TROUBLESHOOTING

JOB SHEET 2--CHECKING FOR A DEFECTIVE SWITCH

I. Tools and materials

A. Neon tester

B. Electrical switch in junction box

C. Screwdriver

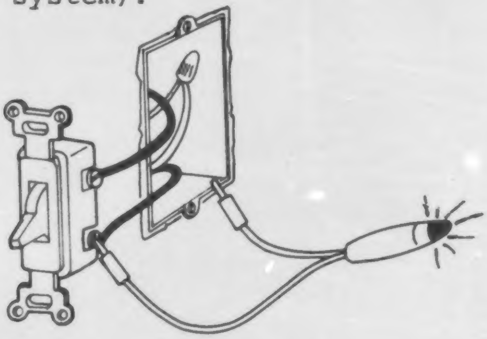
II. Procedure

CAUTION: Instructor MUST be present.

A. Carefully remove switch plate cover.

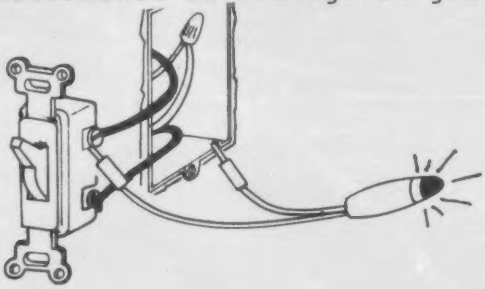
B. Before starting this test procedure, be sure the power to the suspected switch has been turned OFF. Unscrew the switch from the junction box. Pull the safety switch away from the metal box and position it so that no bare wires can touch the box. When the switch is in a safe position, power may be restored and the test procedure started.

C. Position the neon tester as shown in the illustration with one lead on the bottom terminal and the other lead to the metal box (if grounded system).



On older homes and those that have plastic boxes that do not have a ground, it is necessary to remove the wire nut from the neutral wire and use the neutral as the other test point. This test determines if voltage is reaching the switch.

D. With the switch in the on position, voltage should be present at the top terminal of the switch if switch is working correctly. This test determines if voltage is going through switch.



E. If voltage is not present at the top terminal with switch in on position, the switch is defective.

F. Replace switch.

G. If voltage is not present at either bottom or top terminal, the problem is with the circuit breakers (fuses) or in the electrical circuit leading to the troubled switch.

UNIT VI

TROUBLESHOOTING

JOB SHEET 3--CHECKING FOR THE HOT WIRE

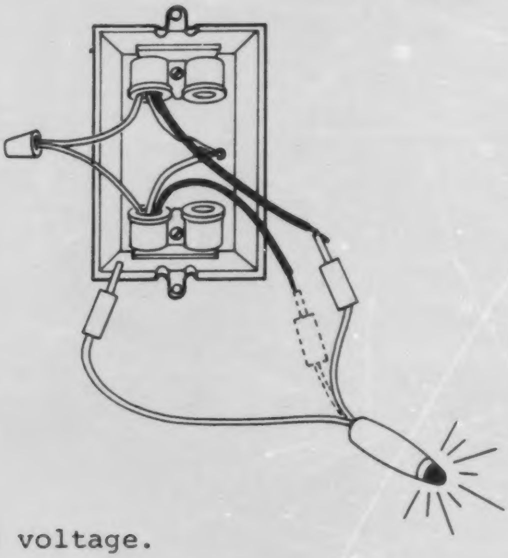
I. Tools and and materials

- A. Neon tester
- B. Receptacle
- C. Screwdriver

II. Procedure

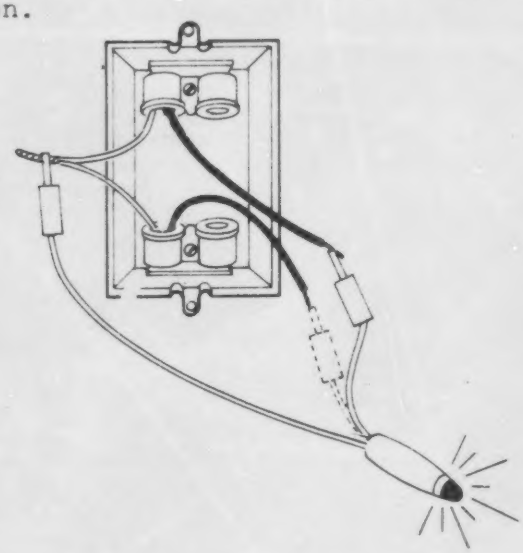
CAUTION: Instructor MUST be present.

- A. Turn OFF power to the wires to be tested.
- B. Remove the free plate of the receptacle, switch, or light fixture so as to gain access to the wire to be tested.
- C. Remove switch, receptacle, or light fixture.
- D. Check for the hot wire in a grounded system.
    1. Separate or disconnect the hot wires as noted in the illustration.



    2. Turn on the voltage.
    3. Carefully place the neon tester leads as shown. (The wire which causes the neon tester to light is the hot lead.)
- E. Check for the hot wire in a non-grounded system.

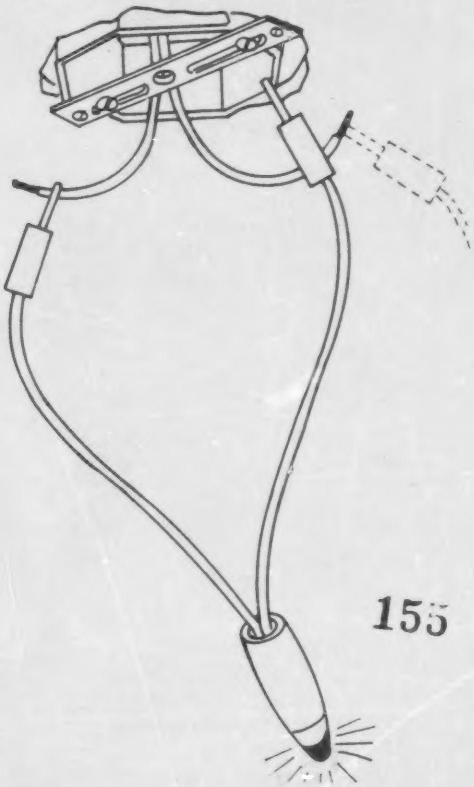
1. Separate or disconnect the hot wires as noted in the illustration.



2. Remove the solderless connector from the neutral wire and use this instead of the metal box.
3. Turn on the voltage.
4. Carefully place the neon tester leads as shown. (As before the wire which causes the tester to light is the hot wire.)

F. Check for the hot wire in a light fixture.

Follow the same procedures as in the previous examples. Note the illustration.



UNIT VI

TROUBLESHOOTING

JOB SHEET 4--CHECKING FOR A DEFECTIVE CIRCUIT BREAKER

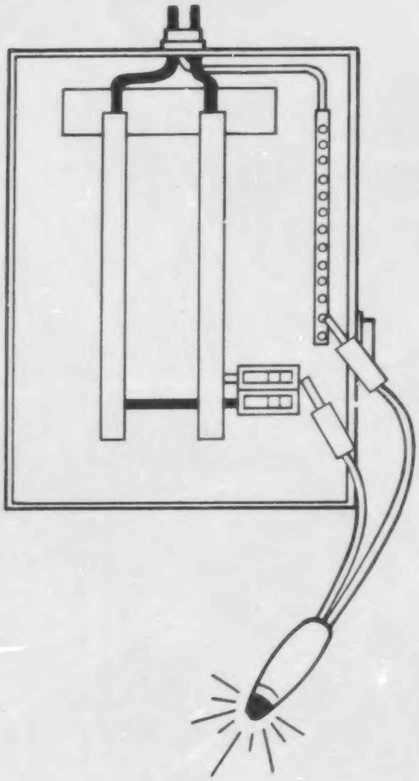
I. Tools and materials

- A. Neon tester
- B. Circuit breakers
- C. Safety glasses

II. Procedure

CAUTION: Instructor MUST be present.

- A. Put on safety glasses.
- B. Open the door of the breaker box.
- C. Place one tester lead on the neutral bar.
- D. Place the other lead on the screw terminal of the circuit breaker. See illustration.



E. If breaker is good, the tester will light when the breaker is in the ON position and will not light when the breaker is in the tripped position.

F. If the tester remains lighted in both positions, the breaker is shorted and should be replaced.

G. If the tester does not light in either position, the breaker is open and should be replaced.

UNIT VI

TROUBLESHOOTING

JOB SHEET 5--CHECKING FOR A DEFECTIVE FUSE

I. Tools and materials

A. Neon tester

B. Live fuse box and fuses

C. Safety glasses

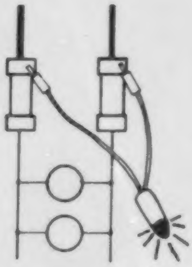
II. Procedure

CAUTION: Instructor MUST be present.

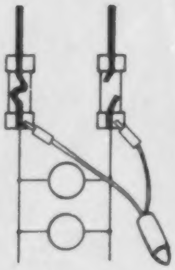
A. Put on safety glasses.

B. Open door to fuse box.

C. Place tester leads to top of fuses to see if voltage is present.

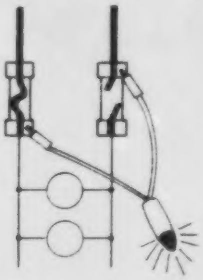


D. Next, place leads on bottom of fuses to see if voltage is passing through fuse.



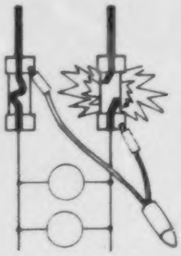
Failure of neon tester to light indicates one or both fuses is defective.

E. Check the left fuse to see if voltage is present.



If light glows, fuse is good. Failure to light shows fuse is defective. Shut OFF power and replace fuse.

F. Check the right fuse to see if voltage is present.



If light glows, fuse is good. Failure to light shows fuse is defective. Shut OFF power and replace fuse.

UNIT VI

TROUBLESHOOTING

TEST

1. Define troubleshooting.

2. List nine basic troubleshooting procedures.

    a.
    b.
    c.
    d.
    e.
    f.
    g.
    h.
    i.

3. Demonstrate the ability to troubleshoot a defective receptacle.

4. Demonstrate the ability to troubleshoot a defective switch.

5. Demonstrate the ability to troubleshoot a defective breaker.

6. Demonstrate the ability to locate the hot wire in a receptacle.

7. Demonstrate the ability to locate the hot wire in a switch.

8. Demonstrate the ability to locate the hot wire in a light fixture.

UNIT VI

TROUBLESHOOTING

ANSWERS TO TEST

1. The process of locating malfunctions in machines and electrical equipment.

2. a. Turn OFF power.

   b. Understand the system.

   c. Ask the owner about the problem.

   d. Inspect the system.

   e. Operate the system.

   f. List possible problem causes.

   g. Reach a conclusion mentally.

   h. Test conclusion physically.

   I. Repair system if possible.

3-8. Evaluated to the satisfaction of the instructor.

UNIT VII

MINOR ELECTRICAL REPAIRS

UNIT OBJECTIVE

After completing this unit, the student will be able to service a fluorescent light fixture, install a pipe-supported light fixture, replace appliance and extension cord plugs, and demonstrate the proper procedure for electrical soldering.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match the terms associated with minor electrical repairs to the correct definition.
2. Identify the parts of a fluorescent light fixture.
3. Identify the parts of a pipe-supported light fixture.
4. Demonstrate the ability to troubleshoot a fluorescent lamp.
5. Change a fluorescent lamp bulb.
6. Install a starter in a fluorescent lamp.
7. Install a pipe-supported light fixture.
8. Replace extension and appliance cord plugs.
9. Solder electrical wire.

UNIT VII

MINOR ELECTRICAL REPAIRS

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

  A. Discuss unit objective with students.

  B. Discuss each specific objective with the students and relate each to making minor electrical repairs.

  C. Organize the sequence of objectives to fit local shop organization and procedures.

  D. Add any objectives that are necessary to fit local needs and program.

II. Information Sheet

  A. Use this information sheet to introduce the terminology used in making minor electrical repairs, and the types of lamps used.

  B. Add any objectives necessary to fit local needs and program.

III. Transparency Masters

  A. TM-1--FLUORESCENT LAMP FIXTURE

  B. TM-2--MULTIPLE SOCKET PIPE-SUPPORTED LAMP FIXTURE

  C. TM-3--FIXTURE INSTALLATION TECHNIQUES

  D. TM-4--FIXTURE INSTALLATION TECHNIQUES

  E. TM-5--FIXTURE INSTALLATION TECHNIQUES

  F. TM-6--COMMON LIGHTING FIXTURES

  G. TM-7--REPLACING PLUG ENDS

  H. TM-8--REWIRING A TWO-PRONG PLUG

  I. TM-9--REWIRING A THREE-PRONG PLUG

IV. Assignment Sheets

  A. ASSIGNMENT SHEET 1--IDENTIFY PARTS OF A FLUORESCENT LAMP FIXTURE

  B. ASSIGNMENT SHEET 2--BASIC SOLDERING PROCEDURES

V. Job Sheets

A. JOB SHEET 1--REPLACING A FLUORESCENT LAMP

B. JOB SHEET 2--INSTALL STARTER IN A FLUORESCENT LAMP

C. JOB SHEET 3--INSTALL PIPE-SUPPORTED LIGHT FIXTURE

D. JOB SHEET 4--REPLACE EXTENSION AND APPLIANCE CORD PLUGS

E. JOB SHEET 5--SOLDER ELECTRICAL CONNECTIONS

VI. Unit Evaluation

A. Give the Unit Test.

B. After checking the test scores, discuss any areas in which students had problems. Give those who need help some additional exercises.

VII. References

A. *Electrical Repairs Made Easy*, Editors of Consumer Guide, Beckman House Publishers, 1980, Publications International, LTD. One Park Avenue, New York, New York, 10016.

B. Taylor, Mark, *Residential Wiring*, Stillwater, OK: State Department of Vocational and Technical Education, 1978.

UNIT VII

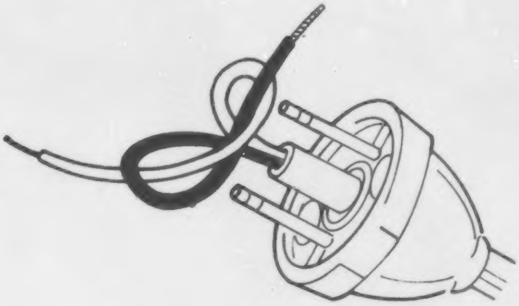
MINOR ELECTRICAL REPAIRS

INFORMATION SHEET

I. Terms and Definitions

A. Rosin core solder--Solder used in electrical work rosin flux core.

B. Underwriter's knot--Knot used in electrical wiring procedures.



C. Ballast--Magnetic coil that adjusts the current through fluorescent bulbs.

D. Starter--Automatic switch on fluorescent fixtures.

E. Incandescent lamp--Electric light bulb in which a filament is heated to give off light by an electric current.

F. Fluorescent lamp--A bulb that consists of a glass tube with its inner wall coated with a material that glows when showered by a gas discharge inside the tube.

II. Parts of a Fluorescent Lamp Fixture (TM-1)

A. Bulb

B. Ballast

C. Starter

D. Holder

E. Starter Socket

III. Troubleshooting Fluorescent lamps

TROUBLESHOOTING FLOURESCENT LAMPS

PROBLEM	CAUSES	REPAIRS
Lamp will not light	1. Burned-out bulb	1. Replace bulb
	2. Defective starter	2. Replace starter
	3. Defective ballast, sometimes accompanied by the odor of burning insulation	3. Consider cost of new ballast in comparison to value of lamp fixture before replacing ballast
	4. Defective switch	4. Replace switch
	5. Lamp not seated correctly in socket	5. Reseat lamp in socket
	6. No power to lamp	6. Check power circuit
Lamp glows dimly	1. Defective bulb	1. Replace bulb
	2. Defective starter	2. Replace starter
Lamp ends are lighted	1. Incorrect wiring	1. Check wiring
	2. Starter is shorted	2. Replace starter
	3. Bulb is burned out	3. Replace bulb
Spiraling or flickering lamp	1. Bulb is burned out	1. Replace bulb
	2. Defective or wrong type of starter	2. Replace starter with one of correct voltage
	3. Low line voltage	3. Check voltage within 10% of 120 volts
	4. Wrong ballast	4. Replace ballast
Lamp flashes ON and OFF repeatedly	1. Defective bulb	1. Replace lamp and starter
	2. Defective starter	2. Replace starter

IV. Parts of a Regular Incandescent Lamp Fixture (TM-2, TM-3) (TM-4, TM-5)

A. Fixture strap

B. Strap mounting screw

C. Threaded pipe

D. Fixture

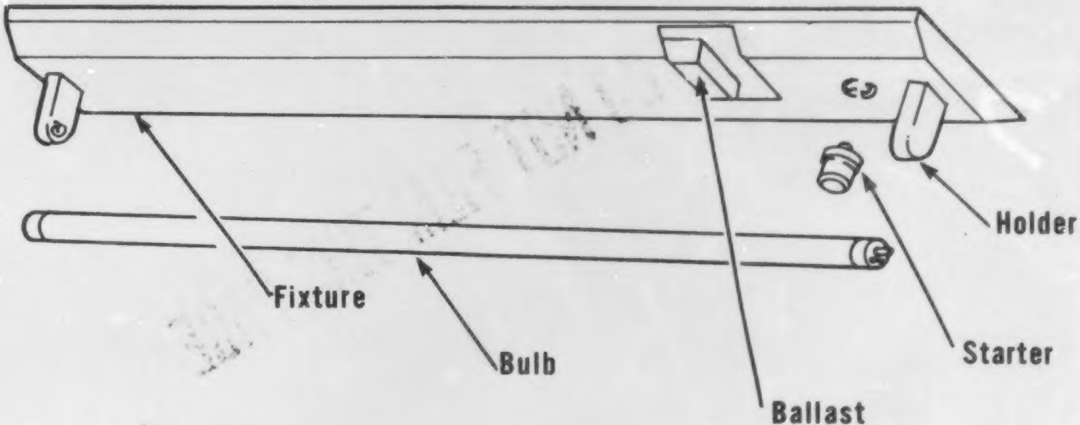
E. Socket

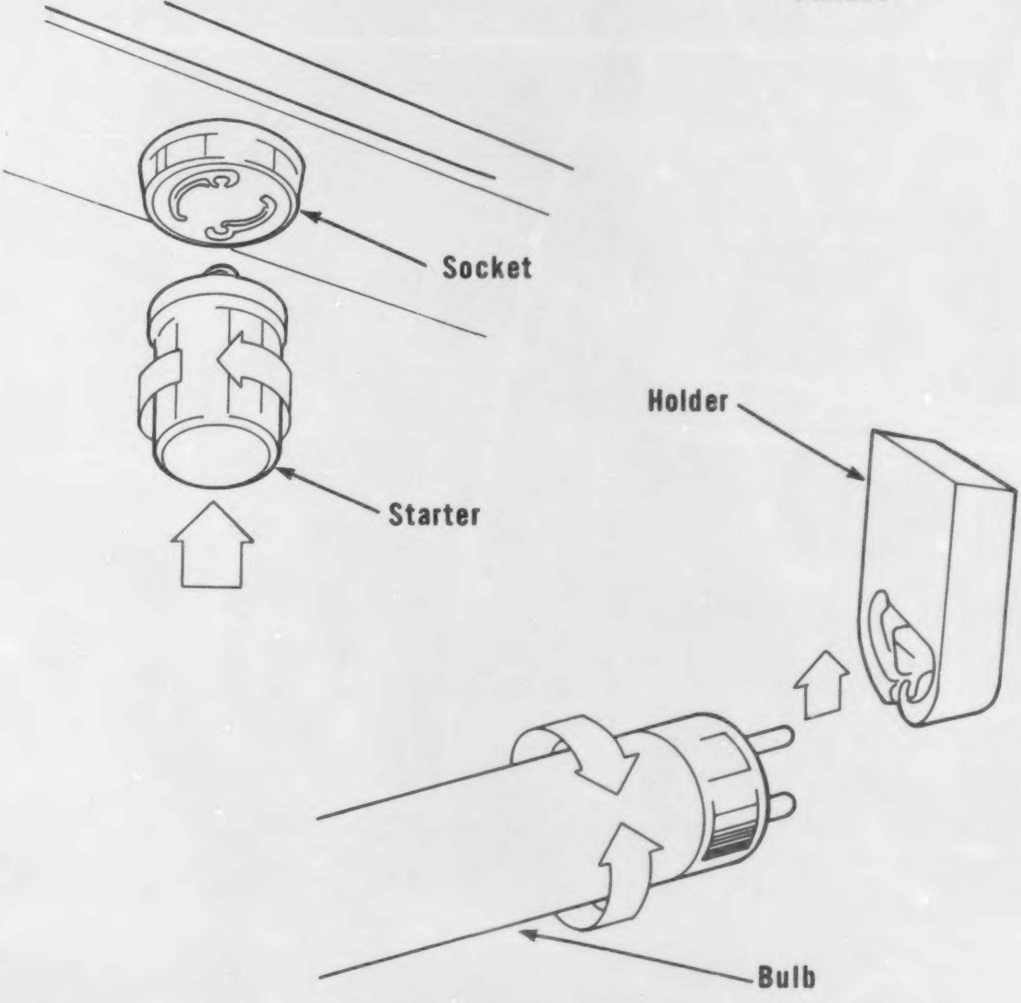
F. Locknuts

V. Common Fixtures (TM-6)

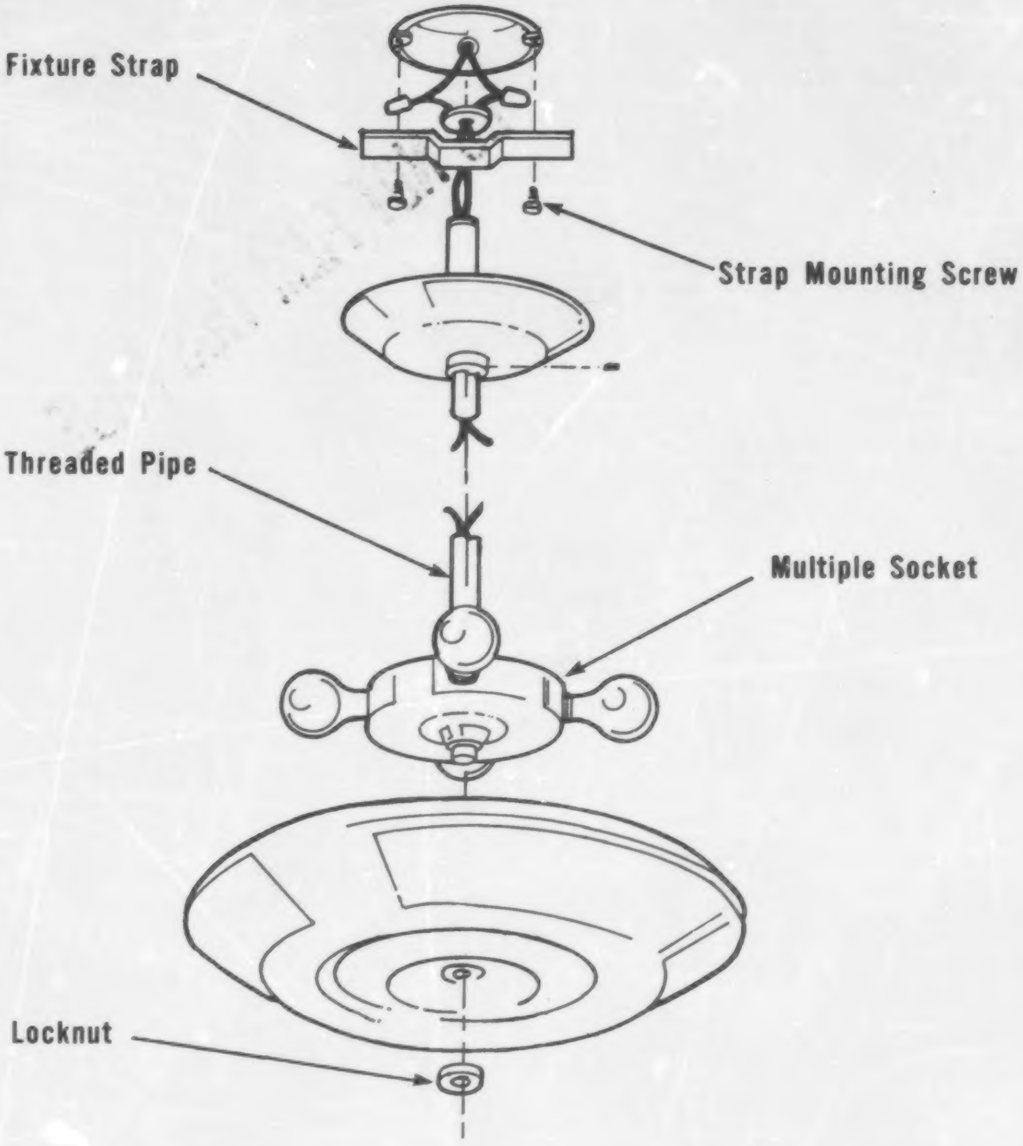
  A. Ceiling fixture
  B. Fluorescent lighting fixture
  C. Recessed lighting fixture
  D. Chandeliers
  E. Outdoor light fixture

FLOURESCENT LAMP FIXTURE



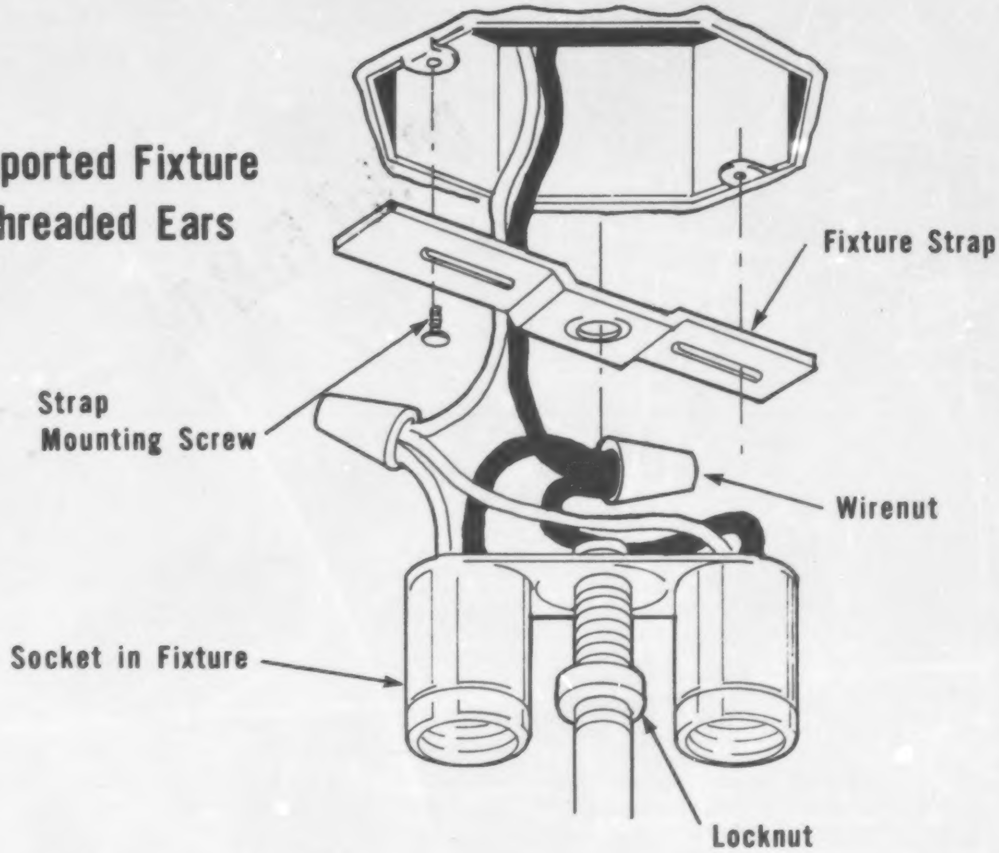


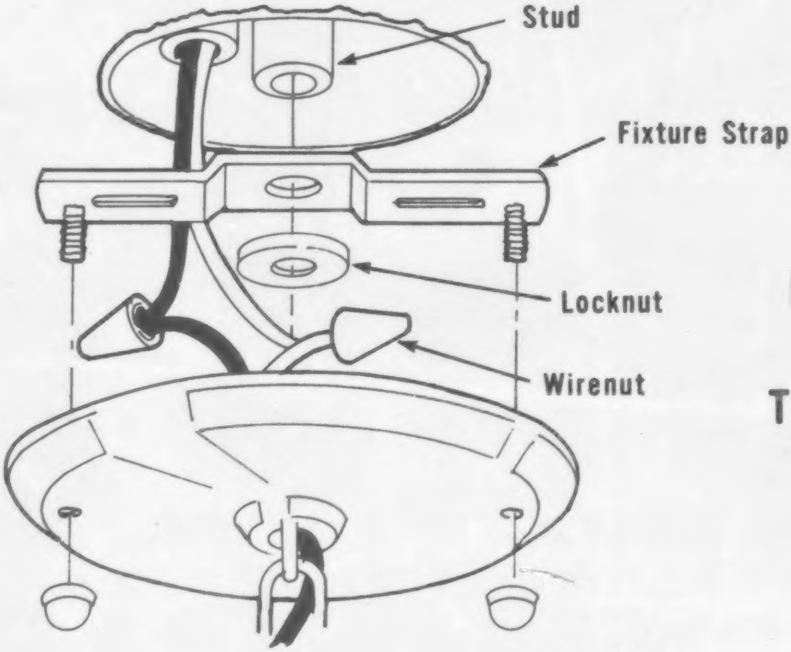
MULTIPLE SOCKET, PIPE-SUPPORTED LAMP FIXTURE



FIXTURE INSTALLATION TECHNIQUES

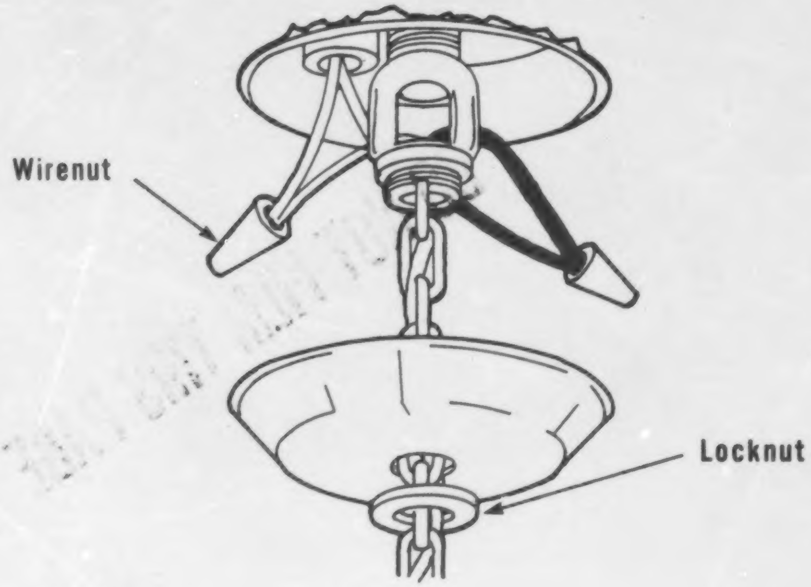
Pipe-Supported Fixture With Threaded Ears

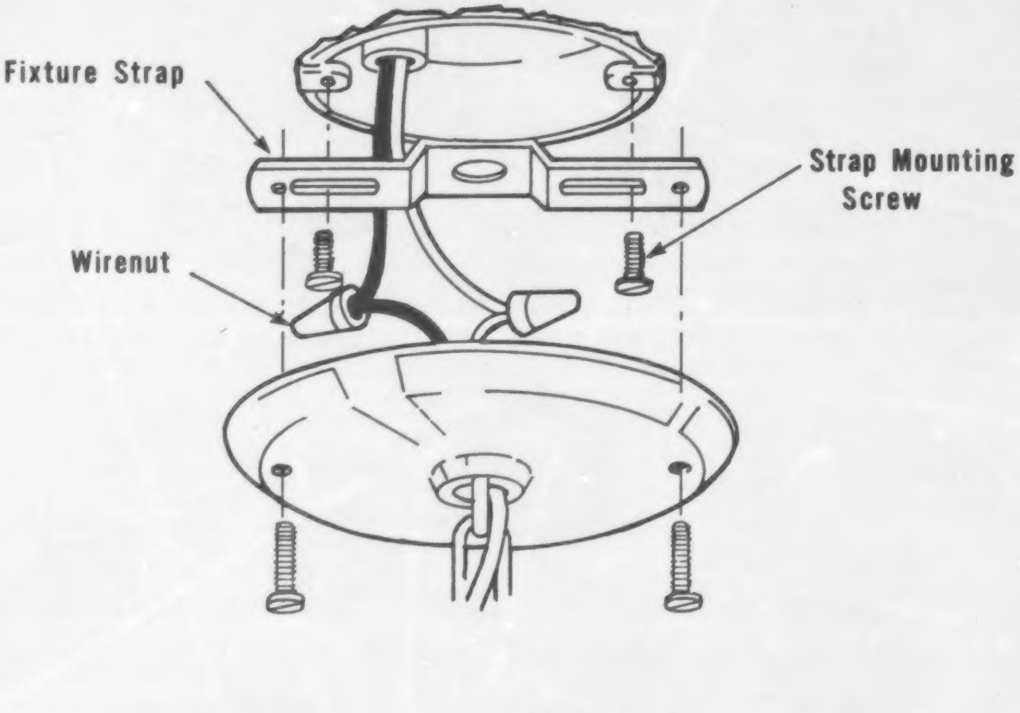




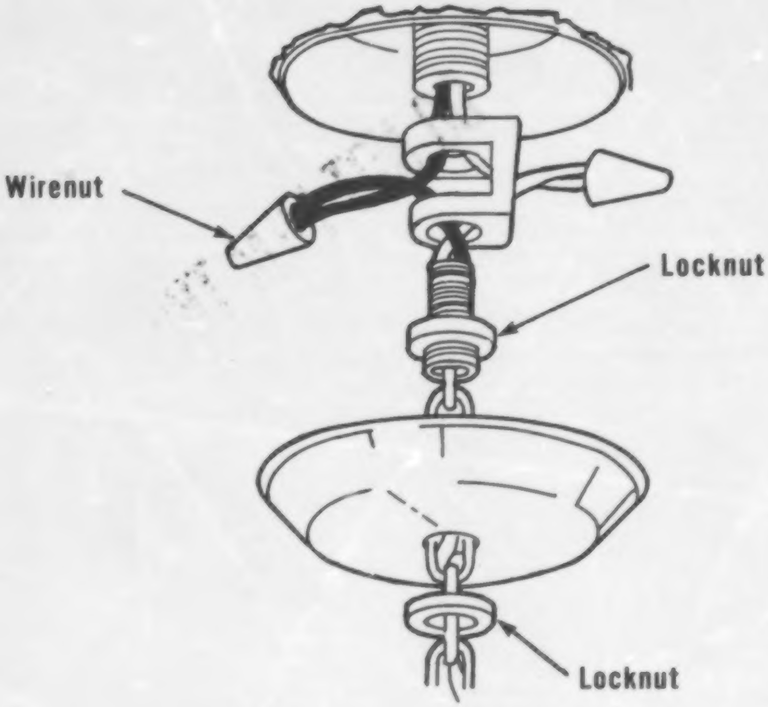
Lamp Fixture With no Threaded Ears

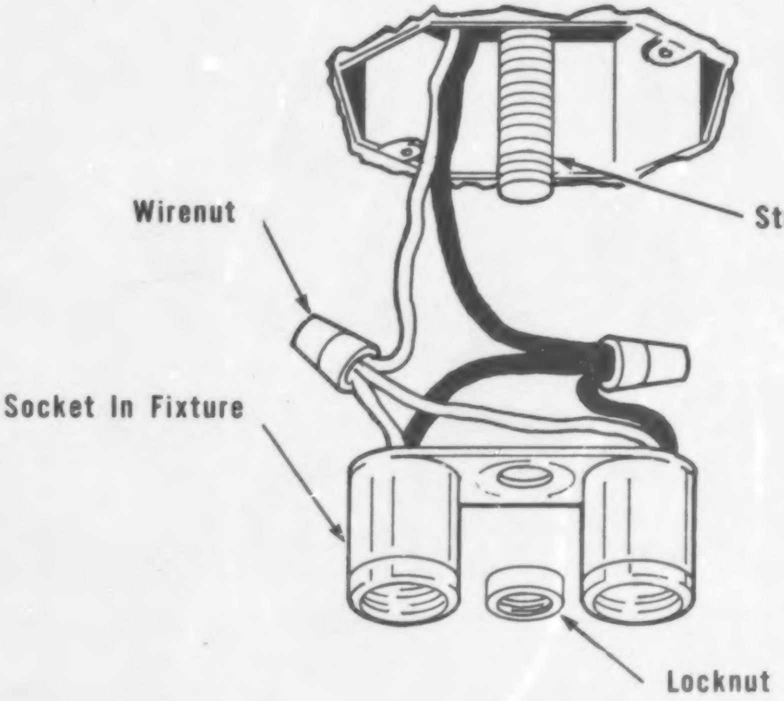
FIXTURE INSTALLATION TECHNIQUES



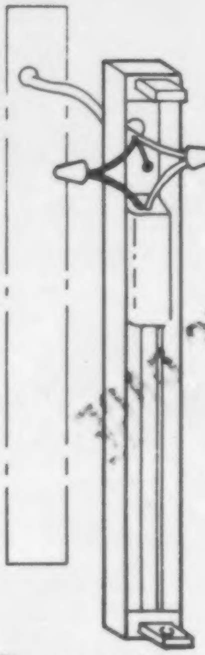


FIXTURE INSTALLATION TECHNIQUES

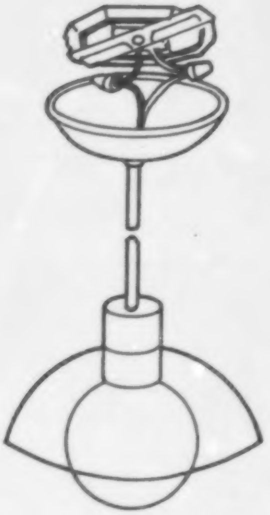




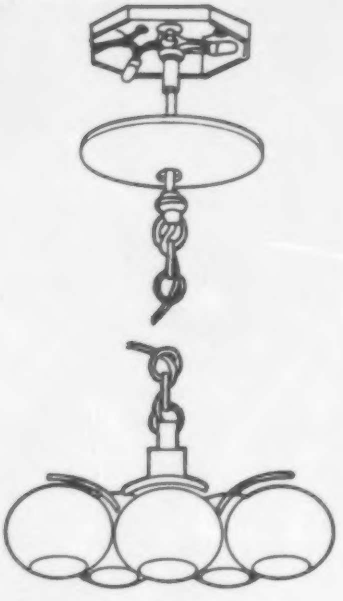
COMMON LIGHTING FIXTURES



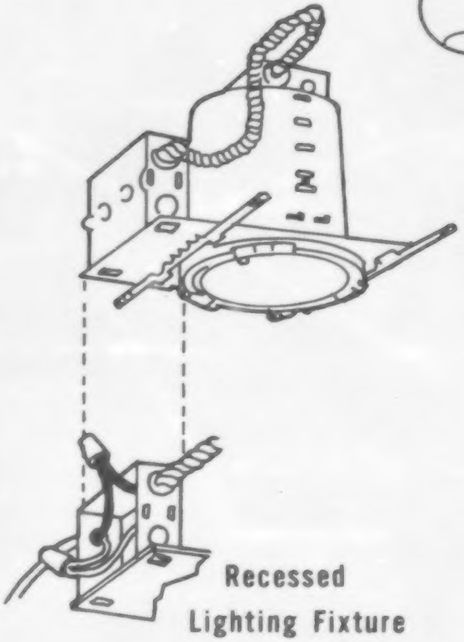
Flourescent Light Fixture



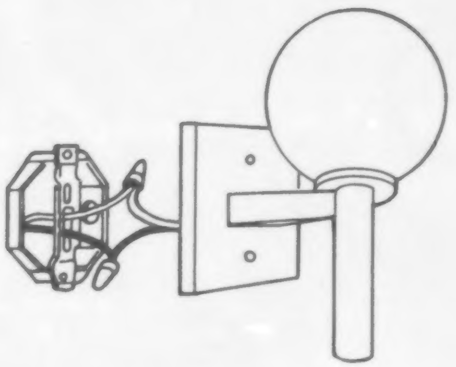
Ceiling Fixture



Chandeliers

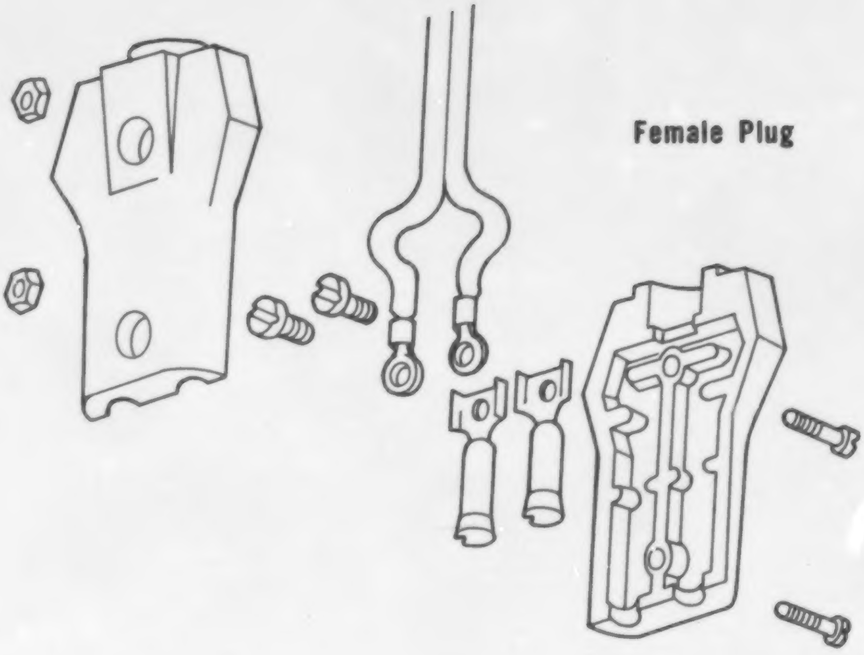


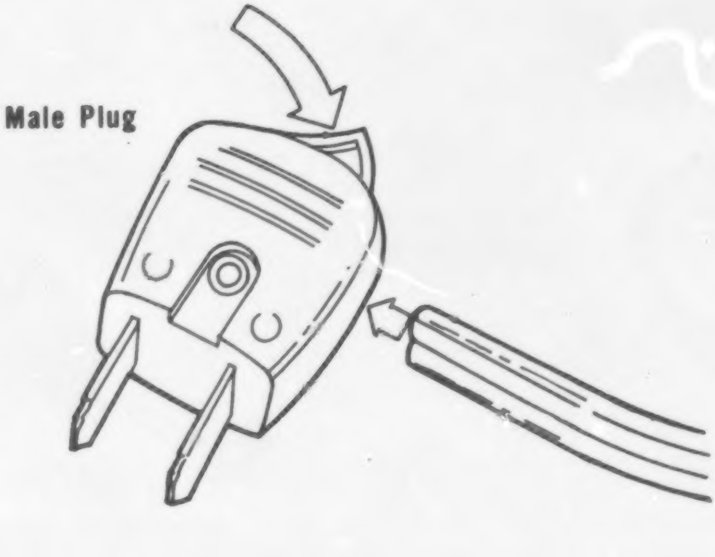
Recessed Lighting Fixture



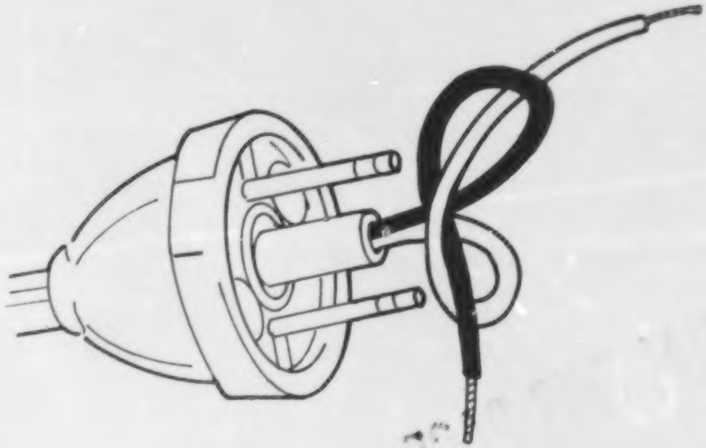
Outdoor Light Fixture

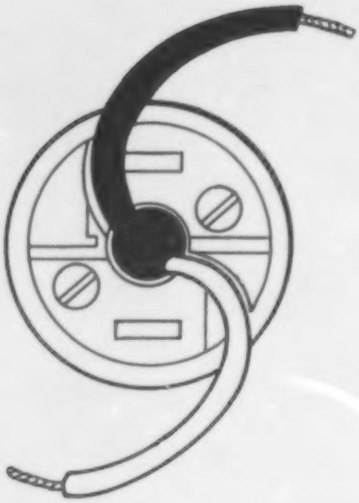
REPLACING PLUG ENDS

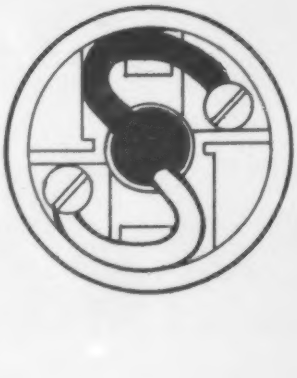




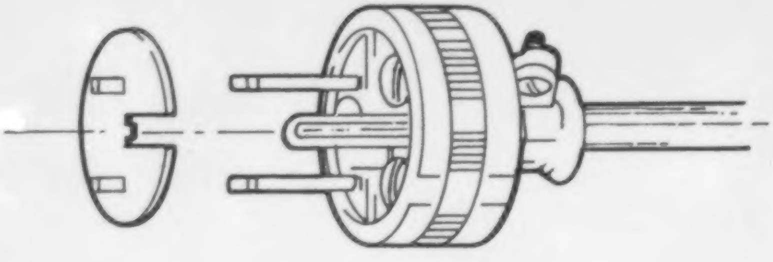
REWIRING A TWO-PRONG PLUG

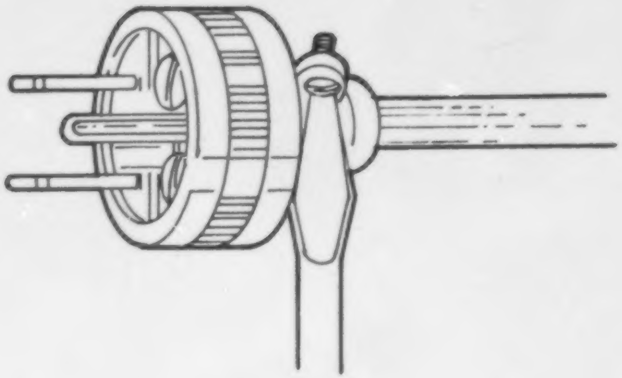


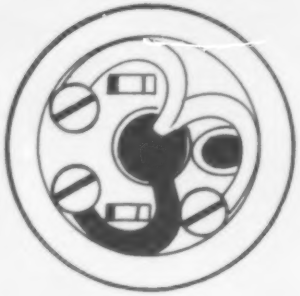


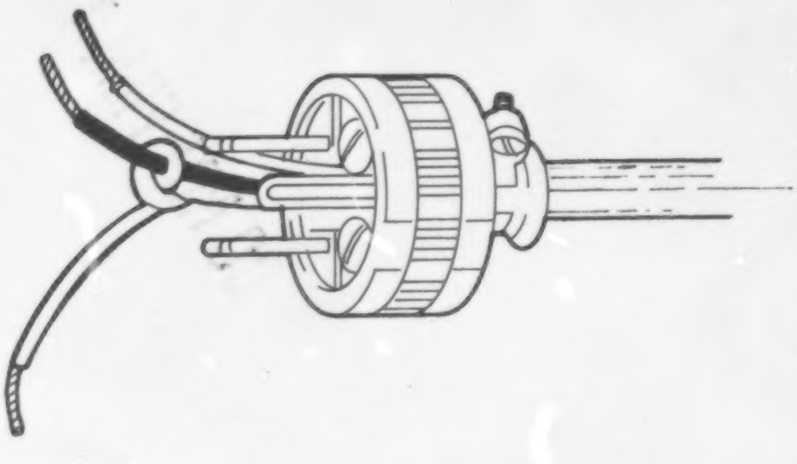


REWIRING A THREE-PRONG PLUG









TM-9

247

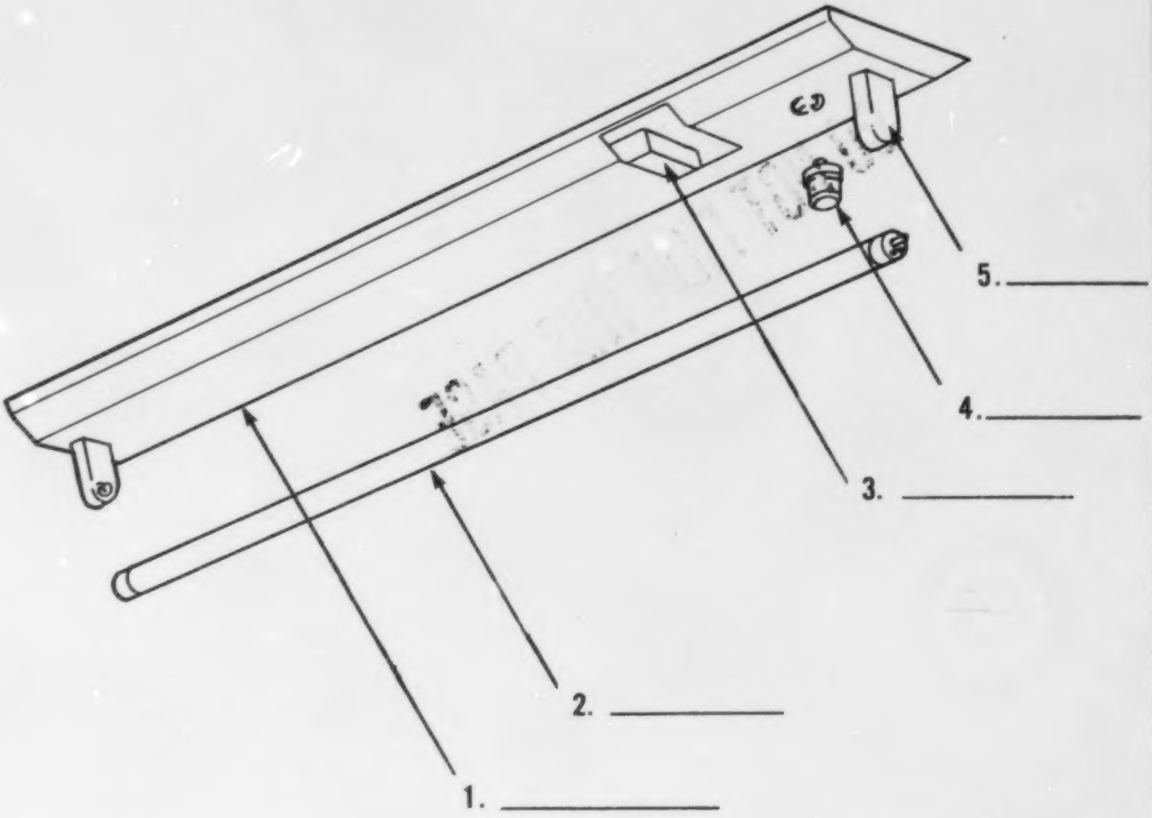
UNIT VII

MINOR ELECTRICAL REPAIRS

ASSIGNMENT SHEET 1--IDENTIFY PARTS OF A FLUORESCENT LAMP FIXTURE

Using the list of terms, select the correct name of each part of a flourescent lamp fixture and write it in the correct blank.

Starter Holder Fixture Bulb Ballast



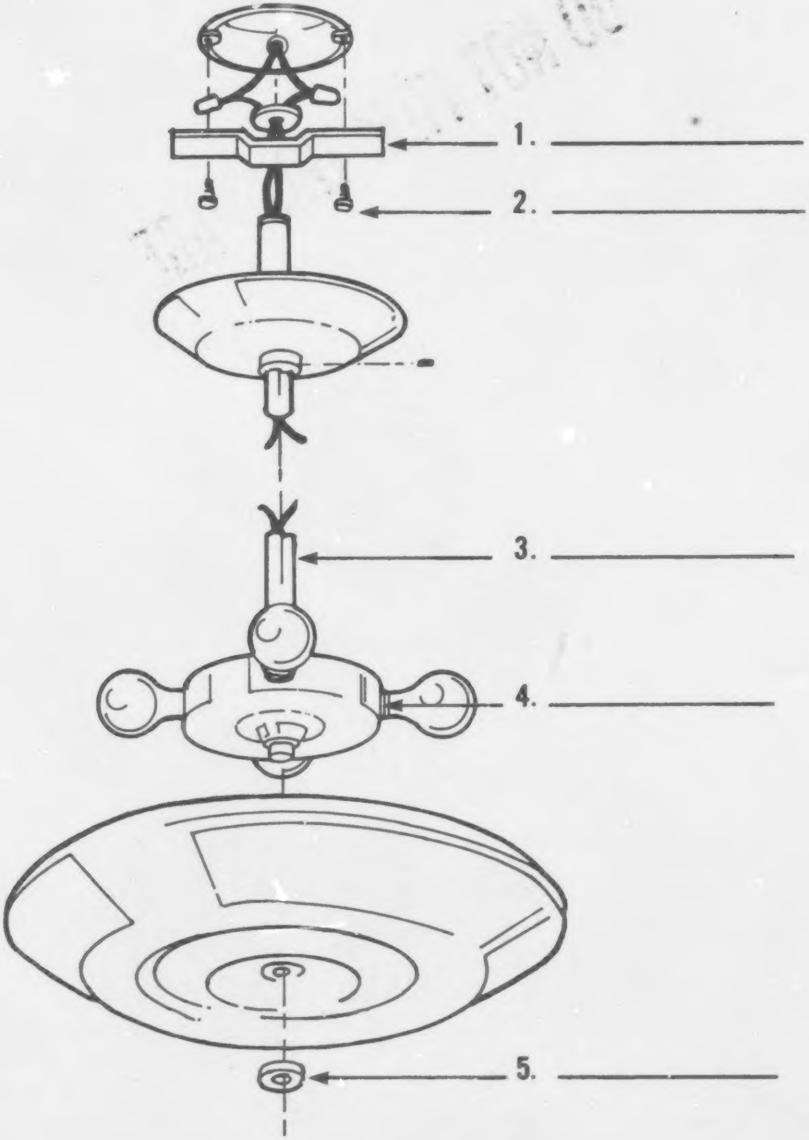
UNIT VII

MINOR ELECTRICAL REPAIRS

ASSIGNMENT SHEET 2--IDENTIFY PARTS OF A PIPE-SUPPORTED LAMP FIXTURE

Using the list of parts given, select the correct name of each part of a pipe-supported lamp fixture and write it in the correct blank.

Locknut
Multiple Socket
Fixture Strap
Strap Mounting screw
Threaded pipe



UNIT VII

MINOR ELECTRICAL REPAIRS

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. Fixture
2. Bulb
3. Ballast
4. Starter
5. Holder

Assignment Sheet 2

1. Fixture strap
2. Strap mounting screw
3. Threaded pipe
4. Multiple socket
5. Locknut

UNIT VII

MINOR ELECTRICAL REPAIRS

JOB SHEET 1--REPLACING A FLUORESCENT LAMP

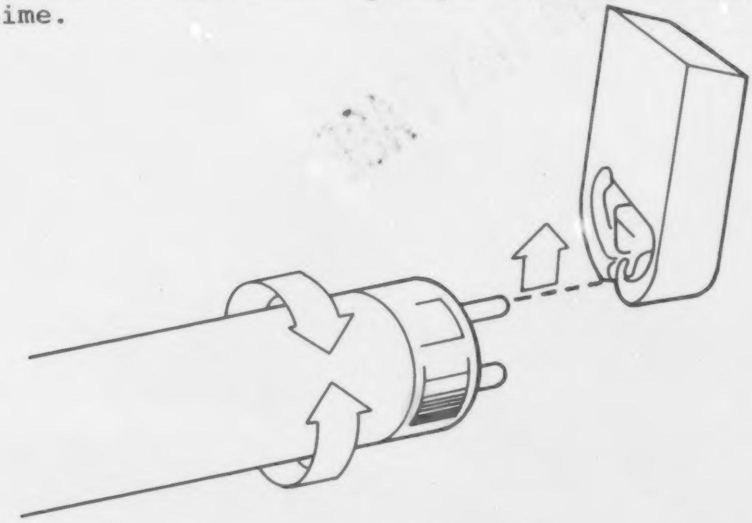
I. Tools and materials

- A. Ladder
- B. Safety glasses
- C. Gloves
- D. New fluorescent bulb

II. Procedure (Put on safety glasses & gloves)

CAUTION: Instructor MUST be present.

- A. Turn OFF power to fixture.
- B. Carefully twist and remove the old bulb to the ground.
- C. Insert the new bulbs' prongs into the holder one end at a time.



- D. Make sure bulb is held firmly by both end holders before releasing.
- E. Turn on power.
- F. Discard old bulbs carefully. They are extremely dangerous and are very likely to explode with very little contact. Do not put old bulbs outside. Destroy them safely inside.

UNIT VII

MINOR ELECTRICAL REPAIRS

JOB SHEET 2--INSTALL A STARTER IN A FLUORESCENT LAMP

I. Tools and materials

   A. Ladder

   B. Safety glasses

   C. Gloves

   D. New starter

II. Procedure

   CAUTION: Instructor MUST be present.

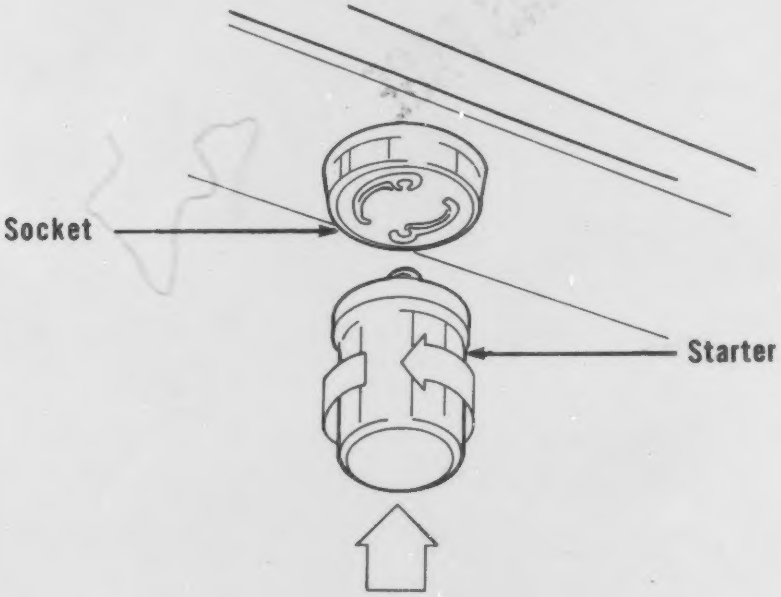
   A. Put on safety glasses and gloves.

   B. Turn OFF power to fixture.

   C. Carefully remove bulb.

   D. Remove old starter by rotating slightly and pulling gently downward.

   E. Install new starter by simply inserting and twisting it slightly to secure it in its socket.



   F. Replace bulb.

   G. Turn on power.

UNIT VII

MINOR ELECTRICAL REPAIRS

JOB SHEET 3--INSTALL A PIPE-SUPPORTED LIGHT FIXTURE

I. Tools and materials

A. Screwdriver
B. Electrician's diagonal cutters
C. Wire strippers
D. Pliers
E. Stepladder
F. Replacement lamp fixture
G. Solderless connectors
H. Safety glasses

II. Procedure

CAUTION: Instructor MUST be present.

A. Turn OFF power to fixture.
B. Put on safety goggles.
C. Carefully remove old locknut on old fixture.
D. Remove old fixture. See (TM-2)
E. Remove solderless connectors.
F. Separate the wires connecting fixture. Before joining new wires of fixture to old circuit wires, you may have to strip old wires before attaching the new fixture.
G. Use the diagonal cutters and wire strippers to prepare old circuit wires.
H. Connect the fixture wires to circuit wires by using solderless connectors.
I. Hold fixture body up to its final mounting position on threaded pipe.
J. Screw threaded pipe into fixture strap far enough so that it holds fixture firmly in place.
K. Screw a bulb in the socket.
L. Place the outer globe fixture in place.
M. Place the outer locknut in position. Be sure to adjust the position of the locknut to keep the fixture secure against the ceiling.
N. Turn on the power and check to see if fixture will light.

UNIT VII

MINOR ELECTRICAL REPAIRS

JOB SHEET 4--REPLACE EXTENSION AND APPLIANCE PLUGS

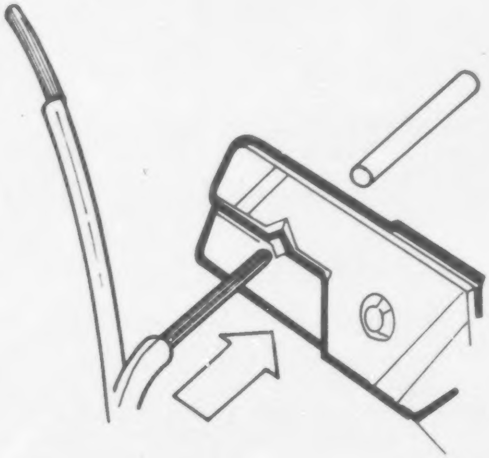
I. Tools and materials

A. Screwdriver
B. Electrician's diagonal cutters
C. Wire strippers
D. Replacement plugs

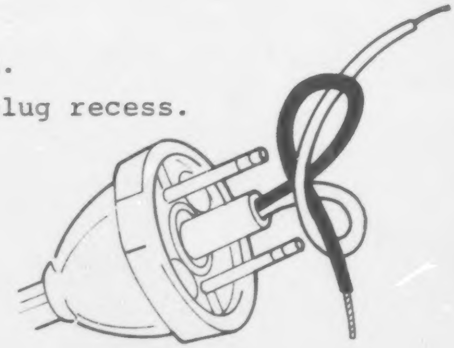
II. Procedure

CAUTION: Instructor MUST be present.

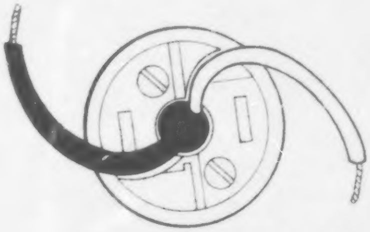
A. Refer to TM-7 (Replacing plugs).
B. Use cutters to remove old plug.
C. Use wire strippers to remove outer insulation.
D. Separate wires.
E. Use wire strippers to remove 1/2 inch of the insulation from wires.



F. Tie underwriter's knot as shown.
G. Tighten knot and pull it into plug recess.

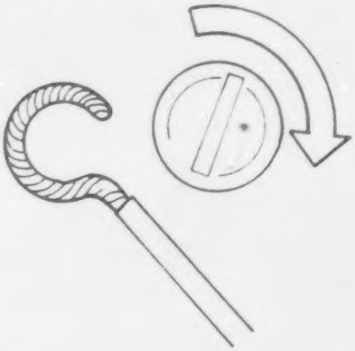


H. Loop each wire around a prong before tightening the bare end under the screw head. This helps keep the wires from touching each other accidentally.

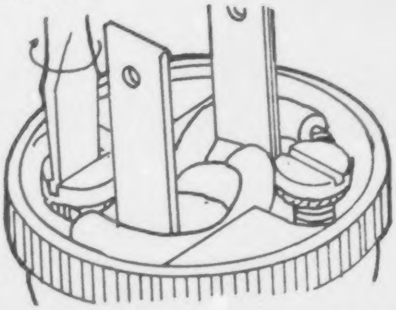


I. Twist strands together if necessary.

J. Loop the end of the wire in a clockwise direction so that the terminal screw will pull the wire tight under the screw head when it is tightened.



K. Tighten screws firmly. The direction of loops should follow screw direction as they are tightened.



I. Check by turning on the power.

M. Clean up work areas, return tools to their proper places.

UNIT VII

MINOR ELECTRICAL REPAIRS

JOB SHEET 5--SOLDERING ELECTRICAL CONNECTIONS

I. Tools and materials

- A. Soldering gun
- B. Lineman's pliers
- C. Wire strippers
- D. Safety glasses
- E. Rosin core solder

  (NOTE: Rosin core or solder and flux are acceptable.)
- F. Two 6-inch pieces of copper conductor.

II. Procedure

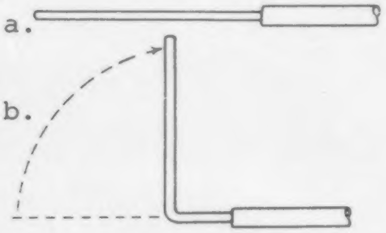
CAUTION: Instructor MUST be present.

- A. Put on safety glasses.
- B. Strip approximately 1 inch of insulation from the conductor.
- C. Form a splice. (Figure 1)

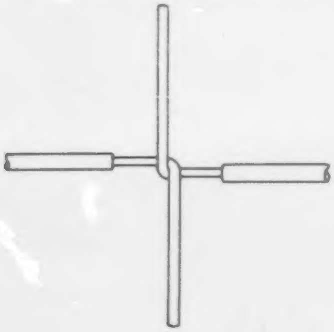
  (NOTE: Any solid splice will work. Two types are illustrated here.)

STRAIGHT SPLICE
FIGURE 1

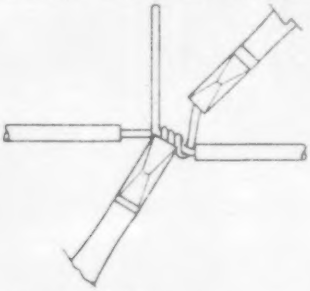
1. Bend 90° angles in both conductors.



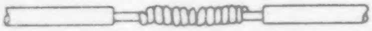
2. Hook conductors together.



3. Hold one conductor secure while wrapping the other.

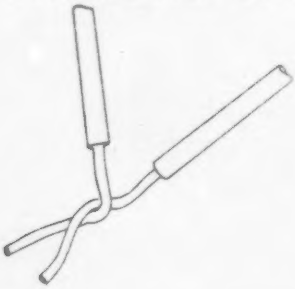


4. Finish straight splice.

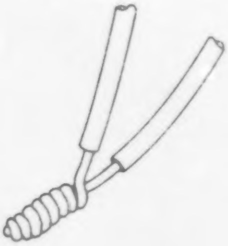


TWIST SPLICE (PIG TAIL)

1. Lap conductors over each other.



2. Twist tightly

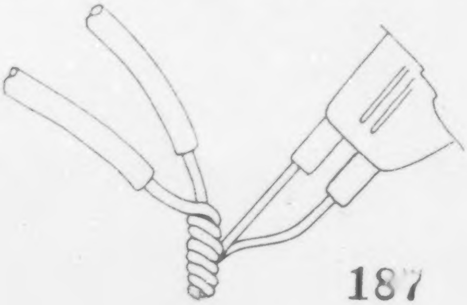


D. Clean tip of soldering gun.

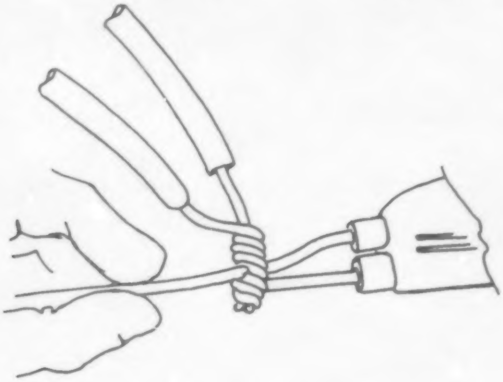
E. Heat gun tip.

(NOTE: You can touch the solder to the gun tip to determine if it is hot enough.

F. Put gun tip on underside of splice to heat it. (Figure 2)



G. Apply solder to top of joint. (Figure 3)



H. Remove soldering gun and solder stick from joint when it has filled.

I. Have the instructor inspect the splice.

J. Clean up tools and replace.

UNIT VII

MINOR ELECTRICAL REPAIRS

TEST

1. Match the terms in the right hand column to the correct definition on the left by placing the number in the blank.

_____ a. Magnetic coil that adjusts current through fluorescent bulbs.

_____ b. Automatic switch on fluorescent fixtures.

_____ c. Knot used in electrical wiring procedures.

_____ d. Solder used in electrical work and has a rosin flux core.

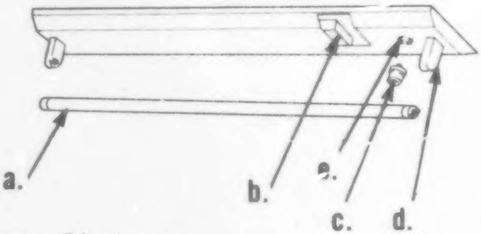
_____ e. Lamp in which a filament is heated.

_____ f. Tube that glows from a gas discharge.

1. Fluorescent lamp
2. Ballast
3. Rosin core solder
4. Starter
5. Underwriter's knot
6. Incandescent lamp

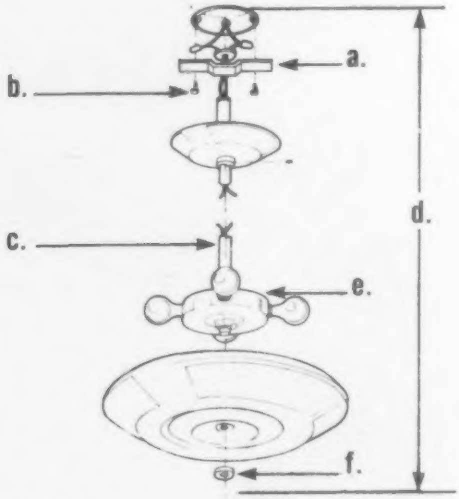
2. Label five parts of a fluorescent lamp fixture.

a.
b.
c.
d.
e.



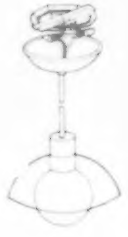
3. Label six parts of a incandescent lamp fixture.

a.
b.
c.
d.
e.
f.

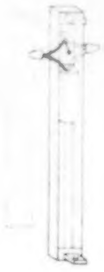


4. Label five common light fixtures.

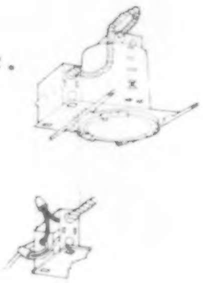
a.



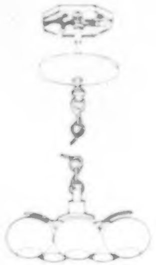
b.



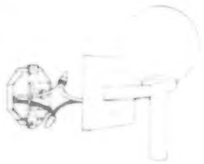
c.



d.



e.



5. List six reasons why a fluorescent lamp will not light.

a.

b.

c.

d.

e.

f.

6. List two reasons why a fluorescent lamp flashes on and off repeatedly.

a.

b.

7. Demonstrate the ability to replace a fluorescent lamp, install a fluorescent starter, install a pipe-supported light fixture, replace extension and appliance cord plugs, and solder various electrical connections.

UNIT VII

MINOR ELECTRICAL REPAIRS

ANSWERS TO TEST

1.
   - 2 a.
   - 4 b.
   - 5 c.
   - 3 d.
   - 6 e.
   - 1 f.

2.
   - a. Bulb
   - b. Ballast
   - c. Starter
   - d. Holder
   - e. Starter socket

3.
   - a. Fixture strap
   - b. Strap mounting screw
   - c. Threaded pipe
   - d. Fixture
   - e. Socket
   - f. Locknuts

4.
   - a. Ceiling fixture
   - b. Fluorescent light
   - c. Recessed light
   - d. Chandeliers
   - e. Outdoor light fixture

5.
   - a. Burned out bulb
   - b. Defective starter
   - c. Defective ballast
   - d. Defective switch
   - e. Lamp not seated correctly
   - f. No power to lamp

6.
   - a. Defective bulb
   - b. Defective starter

7. Evaluated to satisfaction of the instructor.

UNIT VIII

ELECTRIC MOTORS

UNIT OBJECTIVE

After completion of Unit VIII, the student will be able to: identify the parts of an electric motor, select electric motors according to their starting circuits and capabilities, identify types of motor enclosures, and interpret name plate information. This knowledge will be evidenced through demonstration and by satisfactorily completing the test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Define five terms associated with electric motors.
2. Identify four types of A.C. single-phase, induction-run motors.
3. Identify the parts of an induction-run motor.
4. Select electric motors according to their starting circuits and capabilities.
5. Name four types of motor mounts.
6. Name some protective devices used on motors, and give two reasons for using them.
7. Replace an electric motor.
8. Clean the outside of an electric motor.
9. Name five common motor enemies.
10. Name six types of sensing devices used to control electric motors.
11. Demonstrate the ability to read, collect, and interpret name plate information found on electric motors.

UNIT VIII

ELECTRIC MOTORS

SUGGESTED TEACHING PROCEDURES

I. Objective Sheet

  A. Discuss the unit objective with the students.

  B. Discuss each of the specific objectives with the students and relate them to working with electric motors.

  C. Organize the sequence of objectives to fit local shop organization and procedures.

  D. Add any objectives necessary to fit local needs and program.

II. Information Sheet

  A. This sheet introduces the terminology used in relation to electric motors, types of motors and protective devices, and information given on the name plate.

  B. It also lists some ways to detect problems and correct them.

III. Transparency Masters

  A. TM 1--Split-Phase Electric Motor

  B. TM 2--Capacitor-Start,Capacitor-Run Electric Motor

  C. TM 3--Capacitor-Start Electric Motor

  D. TM 4--Repulsion-Start Electric Motor

  E. TM 5--Motor Name Plate

IV. Assignment Sheet--Collect and Interpret Name Plate Information

  A. Stress the importance of the information shown on the name plate.

  B. Discuss how the information could be used in repairing electric motors.

V. Job Sheets

  A. JOB SHEET 1--CLEAN ELECTRIC MOTORS

  B. JOB SHEET 2--REMOVE, CHECK, REPLACE CAPACITOR

VI. Unit Evaluation

A. Give the unit test.

B. Check the tests, and discuss any areas that the students did not understand.

VII. References

A. American Association for Agricultural Engineering and Vocational Agriculture. Athens, Georgia: Farm Electric Motors. (Purchase from Curriculum and Instructional Materials Center, Stillwater, Oklahoma.)

B. Morford, V. J. Farm and Dairy Mechanics. Minneapolis 15, Minnesota: Burgess Publishing Company.

C. Brown, Robert H. Farm Electrification. New York: McGraw-Hill Book Company, Inc.

D. Rockis, Gary. Residential Wiring. American Technical Society. Chicago, IL 60637.

UNIT VIII

ELECTRIC MOTORS

INFORMATION SHEET

I. Terms and definitions

- A. Single-phase--A type of electric service available to most farms requiring one transformer between power supplier and customer
- B. Split-phase motor--The cheapest electric motor available; used for easy starting loads
- C. Induction-run motor--A motor that runs by induced current and does not have windings in the rotor
- D. Repulsion-start motor--A motor that has windings in the rotor and also has brushes and a commutator
- E. Capacitor-start motor--A motor that has a capacitor in the starting windings
- F. Horsepower (hp)--A unit of mechanical power which is equal to 746 watts of electrical power
- G. Short circuit--An improper connection between "hot" and "neutral" wires or between "hot" wires
- H. Three-phase motor--The most rugged, reliable, and satisfactory type of motor available; used for fairly difficult starting loads
- I. Service factor--A multiplier indicating the amount of overload permitted for the motor
- J. RPM--The number of revolutions a motor will turn per minute
- K. Commutator--A switch for reversing the direction of an electric motor

II. Single-phase, induction-run motors (TM-1)

- A. Split-phase
  1. Cheapest electric motor available
  2. Available in sizes up to 1/3 hp
  3. Works on a single-phase power
  4. Operates on 120- and/or 240-volt service
  5. Used on easy starting loads (grinders, saws, washing machines)
- B. Repulsion-start
  1. Uses single-phase power
  2. Uses 120- and/or 240-volt service
  3. Available in sizes from 1/6 to 10 hp
  4. Used on hard-to-start loads

C. Capacitor-start, capacitor-run

1. Uses single-phase power
2. Has two capacitors
    a. One for starting
    b. One for running
3. Available in sizes of 5, 7 1/2, and 10 hp
4. Used on hard-to-start loads

D. Repulsion-start, capacitor-run

1. Uses single-phase power
2. A combination of the two motors listed above

    (NOTE: The capacitor helps maintain running efficiency after the motor reaches operating speed.)

3. Available in sizes of 1 to 15 hp

III. Reason for built-in capacitors--Gives additional starting torque without requiring additional amperage

IV. Motor requirements

A. Must start the equipment load

B. Must drive the load once it is started

C. Must survive the abuse of the surroundings in which it operates

V. Factors in selecting electric motors

A. Type of electric power available

(NOTE: Single-phase or three-phase)

B. Type and size of load

C. Condition under which motor must operate

VI. Replacing electric motors

A. Horsepower rating must be the same or not more than one size larger

B. Full-load speed, cycles, duty, and base must be the same

C. Voltage 120 and/or 240

(NOTE: A 240 voltage preferred for 1/2 hp and larger.)

D. Type should be the same

(NOTE: Type should be the same as the motor being replaced or a type having equal or greater starting torque.)

VII. Reasons for using motor mounts

A. Anchors motor in position

B. Provides for motor adjustment

C. Reduces vibration
D. Provides means of making motor portable

VIII. Reasons for having protective devices

A. Protects excessive overcurrent
B. Prevents short circuits

IX. Causes of excessive current

A. Load too heavy
B. Machine locked or jammed
C. Belt too tight
D. Bearings worn or needing lubrication
E. Voltage lower than name plate indication
F. Motor and equipment pulley out of line

X. Protection for electric motors

A. Built-in overload protection in motor
B. Manual starting switch with overload protection
C. Magnetic starting switch with overload protection
D. Time-delay fuse in motor for disconnect switch

XI. Common motor enemies

A. Dust
B. Stray oil
C. Moisture
D. Bearing friction
E. Pulley misalignment
F. Vibration
G. Uneven wear
H. Overload
I. Inadequate wiring

XII. Sensing devices

A. Temperature
B. Humidity and moisture
C. Light
D. Pressure
E. Timing
F. Reversing
G. Solenoid

XIII. Name plate information (TM-5)

- A. Type of current--Alternating or direct; single-phase or three-phase
- B. Type of overload protection

  (NOTE: The term thermalguard is a manufacturer's identification for a specific overload protection device built into the motor.

- C. Horsepower
- D. RPM--Indicates the speed of the motor shaft
- E. Temperature at which motor is to operate
- F. Hours that motor can be operated continuously
- G. Volts
- H. Type of enclosure
- I. Motor type

  (NOTE: The various manufacturers usually use different letters and symbols to identify the various types of motors as to their starting mechanism. Very often the symbols sp-split-phase start; cs-capacitor-start; and rs-repulsion-start are used.)

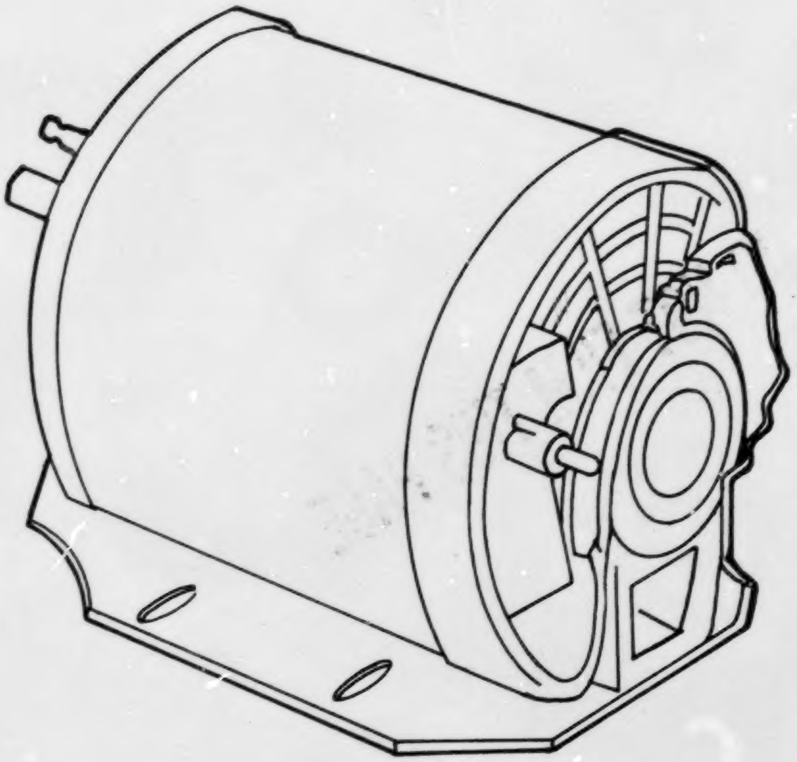
- J. Type of frame
- K. Cycle
- L. Serial number

  (NOTE: This number should be used when writing to the manufacturer regarding the specific motor.)

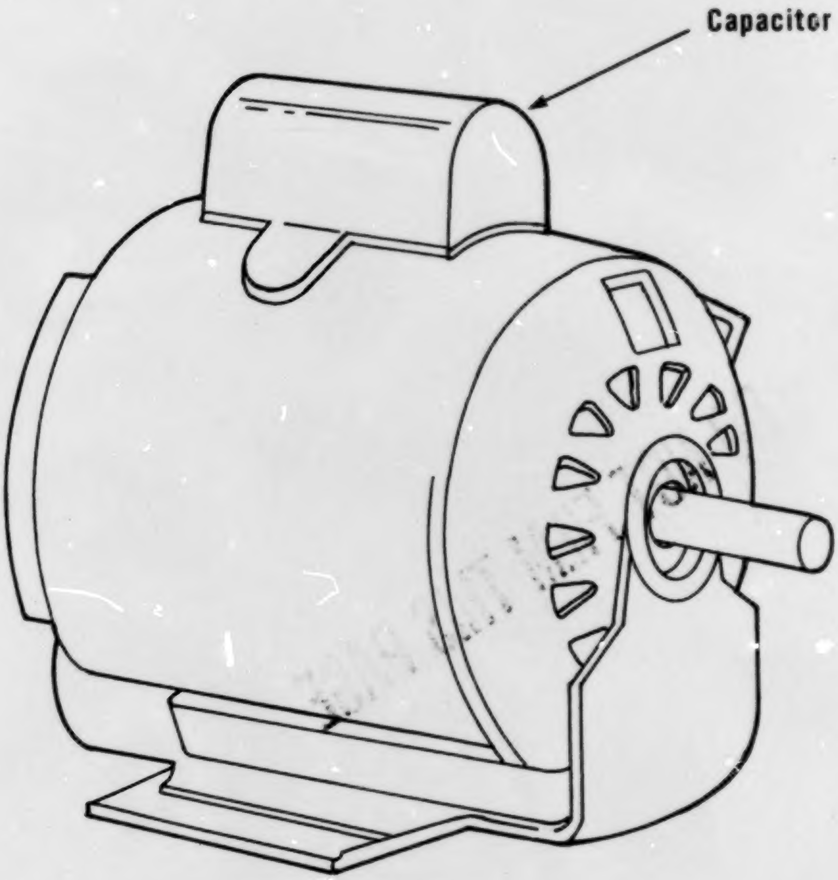
XIV. Troubleshooting Electric Motors

Problem	Possible Cause	Action
Motor does not run	No power at wall outlet	Test outlet
	Open circuit in cord or motor	Test power cords, motor switch
	Dirty commutator	Clean commutator with sandpaper
	Brushes not contacting commutator bars	Clean brushes
	Motor jammed	Turn motor by hand, replace motor.
Motor vibrates noisily	Worn bearings	Disassemble motor, check rotor shaft play, replace motor
	Loose or worn parts	Tighten all screws, nuts, bolts. Replace worn rubber mounts.
Excessive TV or radio interference; sparking from brushes	Short circuit in rotor winding	Remove motor and have it checked
	Rough commutator	Remove motor and have it checked

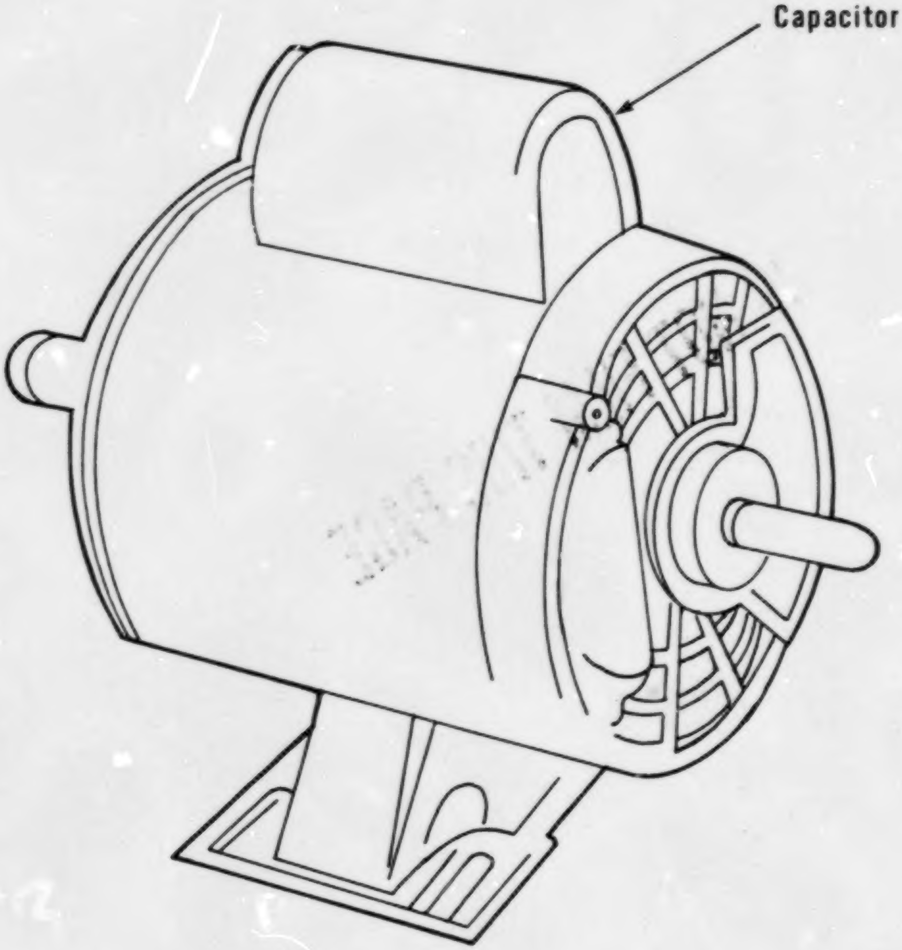
SPLIT-PHASE ELECTRIC MOTOR



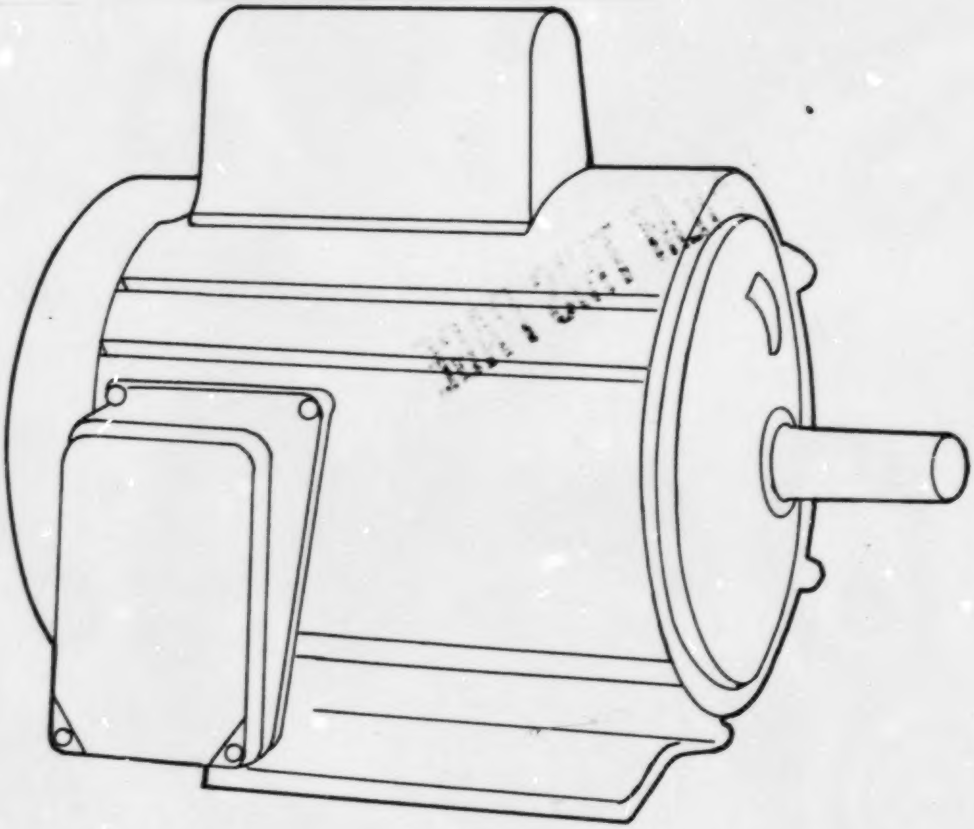
CAPACITOR-START, CAPACITOR-RUN ELECTRIC MOTOR



CAPACITOR-START ELECTRIC MOTOR

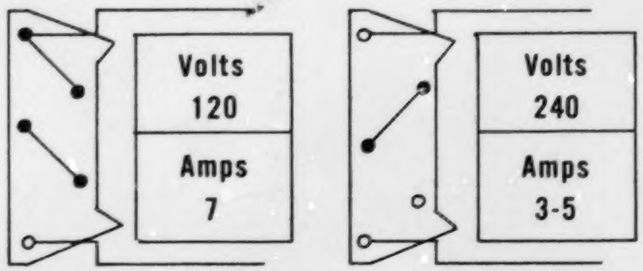


REPULSION-START ELECTRIC MOTOR



MOTOR NAME PLATE

A.C. IPH		Motor Type FJ	
Thermoguard Type		A	
HP 1/2		Frame 186	
R. P. M.	1725	C Y C	60
C 40	Hours Cont.	Locked KV-A	
Serial 1180016-B		Style GO	



Volts 120 — Amps 7

Volts 240 — Amps 3-5

OPEN

30248 MADE IN USA

UNIT VIII

ELECTRIC MOTORS

ASSIGNMENT SHEET--COLLECT AND INTERPRET NAME PLATE INFORMATION

Select an electric motor that is in your school shop or at your home and complete the following questions. Return to instructor when finished for his/her evaluation.

1. What is the horsepower of the motor? ____________________
2. What does the horsepower fraction tell you? ____________________
3. What is the rpm of the motor? ____________________
4. What does rpm tell you about this particular motor? __________ ____
5. What is the recommended voltage to which this motor should be connected? ____________________
6. What type of overload protection does the motor have? __________
7. How long is the motor designed to operate? ____________________
8. Under what temperature will the motor operate? ____________________
9. What type of enclosure does the motor have? ____________________
10. With this type of enclosure, where would you recommend using it? ____________________
11. What is the serial number? ____________________
12. When would you use the serial number of a motor? __________ ____
13. At how many cycles does the motor operate per second? __________
14. What is the motor type? ____________________
15. What type of current does the motor use? ____________________

UNIT VIII

ELECTRIC MOTORS

ANSWERS TO ASSIGNMENT SHEET

1-15. Evaluated to the satisfaction of the instructor.

UNIT VIII

ELECTRIC MOTORS

JOB SHEET 1--CLEAN ELECTRIC MOTORS

I. Tools and equipment

- A. Motor
- B. Standard screwdriver
- C. Open-end adjustable wrench
- D. Tire pump or vacuum cleaner
- E. Hammer
- F. Small socket wrench set

II. Materials

- A. Non-flammable cleaning fluid
- B. Clean rags (lintless)

III. Procedures

- A. Disconnect motor and remove from mounting
- B. Clean out surface of motor
- C. Disconnect wires at motor

  (NOTE: Be sure to pay close attention to label wire positions on motor terminals.)
- D. Remove motor pulley
- E. Clean outside of motor with rags
- F. Blow dust and lint from motor with tire pump or vacuum cleaner
- G. Oil motor and reassemble
- H. Reconnect motor and test

UNIT VIII

ELECTRIC MOTORS

JOB SHEET 2--REMOVE, CHECK, REPLACE CAPACITOR

I. Tools and materials needed

- A. Motor
- B. Standard or phillips screwdriver
- C. Volt-ohm meter
- D. Needle nose pliers

II. Procedures

- A. Disconnect power
- B. Remove screws holding the capacitor cover in place.
- C. Use needle nose pliers to remove wire connectors.
- D. Set volt-ohm meter to RX100 scale and touch its probes to capacitor terminals.
- E. Observe ohm meter. If capacitor is OK, needle will jump to zero ohms, then drift back to high. Steady zero ohms means a short circuit, steady high ohms means an open circuit.
- F. Replace capacitor

UNIT VIII

ELECTRIC MOTORS

UNIT TEST

1. Match the terms in the right hand column to the correct definition on the left by placing the number in the blank.

____ a. a multiplier indicating the amount of overload permitted for the motor

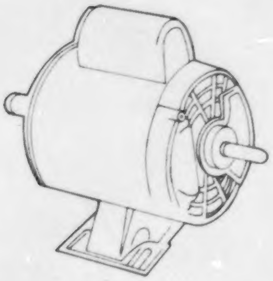
____ b. a type of electrical service available to most farms requiring one transformer between power supplier and customer

____ c. a motor that runs by induced current and does not have windings in the rotor

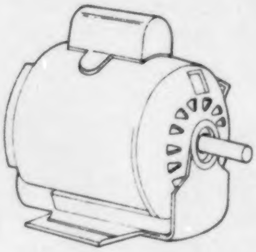
____ d. the number of revolutions a motor will turn per minute

1. induction-run motor
2. service factor
3. relay
4. single-phase
5. RPM

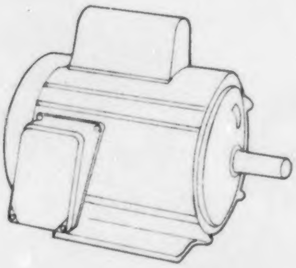
2. Identify the following types of electric motors.



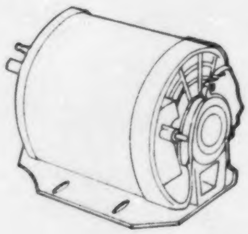
a. ______________



b. ________________



c. ______________



d. ________________

3. Name three electric motor requirements.

   a.

   b.

   c.

4. Place an "X" in the blank below if the statement would aid you in making a decision in regard to replacing an electric motor.

   ____ a. Type does not have to be the same

   ____ b. Voltage either 115 and/or 230

   ____ c. Full load speed, cycles, duty, and base must be the same

   ____ d. Horsepower rating does not apply

5. Name four reasons for using motor mounts

   a.

   b.

   c.

   d.

6. Name two reasons for having protective devices on motors.

   a.

   b.

7. Name six causes of excessive current in electric motors.

   a.

   b.

   c.

   d.

   e.

   f.

8. Name four types of protective devices for electric motors.

   a.

   b.

   c.

   d.

9. Name five common motor enemies.

   a.

   b.

   c.

   d.

   e.

UNIT VIII

ELECTRIC MOTORS

ANSWERS TO TEST

1\.
2 a.
4 b.
1 c.
5 d.

2\.
a. Capacitor-start
b. Capacitor-start, capacitor-run
c. Repulsion-start
d. Split-phase

3\.
a. Must start the equipment load
b. Must drive the load once it is started
c. Must survive the abuse of the surroundings in which it operates

4\.
____ a.
____ b.
x c.
____ d.

5\.
a. Anchors motor in position
b. Provides for motor adjustment
c. Reduces vibration
d. Provides means of making motor portable

6\.
a. Protects excessive overcurrent
b. Prevents short circuits

7\.
a. Load too heavy
b. Machine locked or jammed
c. Belt too tight
d. Bearings worn or needing lubrication
e. Voltage lower than name plate indication
f. Motor and equipment pulley out of line

8\.
a. Built-in overload protection in motor
b. Manual starting switch with overload protection
c. Magnetic starting switch with overload protection
d. Time-delay fuse in motor for disconnect switch

9. Five from:
a. Dust
b. Stray oil
c. Moisture
d. Bearing friction
e. Pulley misalignment
f. Vibration
g. Uneven wear
h. Overload
i. Inadequate wiring